ASSOCIATIONS BETWEEN WORKING MEMORY, HEALTH LITERACY AND RECALL OF THE WARNING SIGNS OF STROKE AMONG OLDER ADULTS

by

Christine Anneliese Ganzer

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SIGNED: Christine Anneliese Ganzer
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Over the years, I have discovered life is a journey, a pilgrimage, and an adventure. There is so much that I have learned during this incredible trip. I am so fortunate to have met so many exceptionally talented individuals along the way and it is with their support and guidance that I now finish this very important chapter with the tools needed to begin a new journey that will be my life’s passion.

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The secret of a good memory is attention, and attention to a subject depends upon our interest in it. We rarely forget that which has made a deep impression on our minds. Tryon Edwards (1809 – 1894)
DEDICATION

There is nothing in this world more important than family. We are a team and I love you all so very much. Thank you for doing this with me.
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ABSTRACT

Older adults constitute a growing population in the United States. A disproportionate percentage of this population experience chronic illnesses and need to recall information important to prevent complications of illness and to self-manage their condition. One example of the need to retain information is to recall the risk factors for ischemic stroke to prevent the damaging effects of stroke.

Factors that could influence the recall of health information include age-related changes in cognition, specifically working memory capacity or the amount of information that can be held in memory and manipulated at any one time. Research supports that older adults have working memory capacity limitations. Older adults may also experience low health literacy that in combination with declines in working memory could further influence recall of health information.

The purpose of this study was to describe the predictive relationships of working memory capacity and health literacy on the recall of the warning signs of stroke in a sample of older community dwelling elders.

Fifty-six participants, ranging in age from 68-99 years of age (M= 80 years of age) were recruited from two sites, a Senior Center and Retirement Residence. Participants were enrolled once they were determined not to have a visual impairment, as assessed by the Rosenbaum Vision Screen, cognitive impairment as determined by the Mini Mental State Examination or a depressed mood, as assessed by the Geriatric Depression Scale-Short Form. A brochure published by the American Heart and Stroke Association, “Let’s Talk About Stroke” was the tool used to deliver the health information regarding the five warning signs of stroke. Personal
factors including demographic and medical variables were collected in this study. Working Memory was assessed using the Wechsler Adult Intelligence Scale III, Working Memory Index (WMI). Health literacy was determined using the Short Test of Functional Health Literacy in Adults (STOFHLA). Participants were asked to recall the health information they were asked to read regarding the five warning signs of stroke at the conclusion of the study visit.

Findings indicated that the key variables working memory and health literacy were independently and positively correlated to recall (p < .01); however, regression analysis did not demonstrate an interaction between the two key variables and recall. Education was the only personal factor that was positively correlated with health literacy and recall in this sample.

The findings from this study explore the associations between working memory, health literacy and personal factors and support that these key predictors may be related to the older adults ability to successfully recall health information.
CHAPTER I : INTRODUCTION

Older adults are healthier than in the past although age continues to be associated with the development of chronic illness (U.S. Department of Health and Human Services Administration on Aging, 2008). Older adults experience more chronic illnesses than any other age group. On average, adults aged 60 years and older have 2.2 chronic illnesses, contributing to the over 60 million Americans with multiple morbidities (Schoenberg, Kim, Edwards, & Fleming, 2007). Consistently, about 1 in 5 Americans have a disability, and the number is expected to increase as baby boomers age in the United States (Centers for Disease Control and Prevention, 2007, 2009). Since the 1960’s, mortality rates have declined and older adults are living longer (U. S. Bureau of the Census, 2001). Therefore, preventing the deleterious effects of chronic conditions and promoting the self-management of these conditions are significant concerns.

Of particular importance is the ability of older adults to recall essential information important to their health and well-being. Memory for health information involves cognitive processes, but advancing age is associated with declines in specific cognitive processes, for example, in working memory (Bialystok & Craik, 2006). Older adults have also been shown to experience lower health literacy levels (Baker, Gazmararian, Sudano, & Patterson, 2000a). While much is known about how these factors independently influence older adults’ ability to recall information, research investigating the effect of the interaction between working memory and health literacy on recall is less well understood. Understanding the interaction of these factors could promote health and prevent disability. For example, the successful recall of the warning signs of stroke could prompt fast action and prevent the deleterious effects of stroke.
Knowing if limitations in working memory and lower health literacy places the individual at greater risk, is the first step in identifying strategies that might assist in improving the recall of health information.

Stroke is the leading cause of disability and the third leading cause of death in the United States (Rosamond, et al., 2007). Preventing the effects of stroke begins with recalling the warning signs. Older adults with age-associated declines in particular memory processes combined with limited health literacy may experience difficulties recalling health information. The failure to recall important health messages can lead to disability impacting quality of life and causing increases in the cost of caring for seniors (National Center for Chronic Disease Prevention and Health Promotion, 2004). Thus, the focus of this study is on cognitive factors including working memory and health literacy that have the potential to influence the recall of health information regarding the warning signs of stroke in older adults.

Significance

Prevention of chronic illnesses and disability is notably important because of the significant burden imposed on both individuals and families. Among older adults, chronic illness and related activity limitations are a major problem, and these conditions often reduce seniors’ quality of life (Administration on Aging, 1998). Remembering medical information specific to prevention and self-management of a disease process or treatment regimen is important because better recall of information may enhance the chance that the older adult responds appropriately when treatment-related problems occur (Jansen, et al., 2008).

Of particular interest to this study are stroke and its prevention. Stroke is a major cause of mortality and disability, with an annual consumption of approximately 3% of the US total health
expenditure (Flynn, Macwalter, & Doney, 2008). Furthermore, stroke is a primary cause of serious, long-term disability in adults in the United States (Robinson & Merrill, 2003). Stroke affects more than 700,000 individuals annually. About 500,000 of these are first attacks and 200,000 are recurrent attacks (Flynn, et al., 2008). According to the American Heart Association and the National Heart, Lung, and Blood Institute the cost of cardiovascular diseases and stroke in the United States in 2008 was an estimated $448.5 billion and this is projected to increase.

The recall of the warning signs of stroke is important to older adults for several reasons. The cost of experiencing a stroke is considerable and not limited to dollars. Individuals who suffer a stroke often encounter declines in quality of life because the physical and cognitive consequences of stroke have devastating effects. Brain injury resulting from a stroke can affect the entire body or be limited to a specific region or body part. In severe cases, the personal costs of stroke can leave the older adult with visual disturbances, limitations in motor activity, and difficulties with speech and the ability to understand speech (Alverzo, Brigante, & McNish, 2007). Post stroke complications can include incontinence, swallowing difficulties, fatigue and intractable pain (McCullagh, Brigstocke, Donaldson, & Kalra, 2005). Pain management and fall prevention are significant post stroke problems that require constant monitoring and care.

Behavioral changes can also occur post-stroke and manifest as alterations in memory and emotions (Donnan, Fisher, Macleod, & Davis, 2008). Psychologically, stroke can alter thought processes and in some cases co-occurring clinical depression may necessitate the use of antidepressants (Hama, et al., 2007). The long term complications of stroke related to decreased mobility increase the risk for medical conditions such as pneumonia and decubitus ulcers that often result in mortality (Langhorne, et al., 2000). The experience of stroke imposes a substantial
burden on the individual and society. While the majority of people survive an ischemic stroke, many are left with some form of disability and up to a third of sufferers remain functionally dependent one year after their stroke requiring long-term medical care or institutionalization (Brown, et al., 2006). The economic burden of stroke recovery is devastating to the individual, family and society. Post stroke patients may ultimately require long-term nursing care further increasing the personal and financial burden.

In summary, stroke is costly on many levels, including psychologically, socially and economically. Older adults who are able to recall the warning signs that may alert them to an impending stroke may significantly benefit from this increased awareness and improve prevention and treatment outcomes.

Background

Recall of Health Messages

Older adults frequently experience a chronic health illness and thus are exposed to several types of medical information, including guides to prevent damaging consequences of the illness, treatment recommendations and instructions for using medications and home medical devices (Park & Liu, 2007). The delivery of medical information can be accomplished verbally or through written text such as a standardized brochure and is based on the premise that dissemination of information influences people's knowledge and in turn their ability to make informed decisions about their health care (Mandana, 2007). Therefore, older adults’ ability to successfully recall a health message is paramount if they are to benefit from the information to which they are exposed. There are several steps involved in the recall process. Initially information is encoded and stored in memory and then it must be retrieved in order to be used.
The recollection of information is an essential part of performing daily activities and involves accessing information from memory stores often through the use of cues that assist in the retrieval process. Information can also be recalled freely, that is, without cues. The process of recall is dependent upon cognitive abilities such as working memory.

*Working Memory Capacity*

The processing of information is complex. Working memory plays a crucial role in holding and manipulating information. Carrying out a mental task requires that we take in information while simultaneously recalling information from long term memory stores. Working memory is defined as a system that is responsible for the temporary storage and management of information that is required to carry out cognitive tasks such as learning, reasoning, and comprehension. Importantly, the theory of working memory posits that there is a limitation in the amount of information that an individual can hold and manipulate within the mind at any one time (Baddeley, 2003; Miller, 1956; Was & Woltz, 2007).

As people age, the cognitive resources they have available to process information become more limited (Park, Morrell, & Shifren, 1999). Older adults have documented declines in working memory capacity that occur as a part of the aging process (Baddeley, 1996; Fritsch, et al., 2007; Jonides, et al., 2008). A limitation in the amount of available working memory capacity constrains the amount of information that can be processed, stored and retrieved. The presentation of health information can be considered taxing to a capacity limited working memory because learning new information requires that the older adult engage in increased mental effort (Velanova, Lustig, Jacoby, & Buckner, 2007). Thus, limits to working memory capacity with age pose an additional barrier to improving the health outcomes of older adults via
health messages. The capacity to recall health messages is an important factor to consider when presenting older adults with information intended to inform the public.

**Health Literacy**

Navigating through the health care system requires that individuals possess a minimal set of skills that will allow them to effectively engage in the health care encounter. These skills have been described as an individual’s degree of “health literacy”. Healthy People 2010 define health literacy as "the degree to which individuals have the capacity to obtain, process, and understand basic health information and services needed to make appropriate health decisions" (US Department of Health and Human Services, 2000). It is considered an important skill necessary to navigate complex health care environments and encompasses the ability to understand instructions on prescription drug bottles, appointment slips, medical education brochures, doctor's directions and consent forms. Health literacy comprises a complex set of reading, listening, analytical, and decision-making skills, and the ability to apply these skills to health situations (US Department of Health and Human Services, 2000).

As of the mid-nineties, two thirds of U.S. adults age 60 and over had inadequate or marginal literacy skills, and 81 percent of patients age 60 and older at a public hospital could not read or understand basic materials such as prescription labels (Wolf, Gazmararian, & Baker, 2007). Older adults with poor literacy skills have demonstrated poorer health outcomes on self-reported measures of health and increased rates of morbidity and mortality (Schillinger, Barton, Karter, Wang, & Adler, 2006; Sudore, et al., 2006). The elderly need to have strong health information skills to adequately manage their medical care. Several research studies have found inadequate health literacy in populations of community dwelling adults (Baker, et al., 2007;
Gazmararian, et al., 1999; Pepe & Chodzko-Zajko, 1997; Wolf, Gazmararian, & Baker, 2005). Research demonstrated that patients with limited health literacy had poorer knowledge about health conditions, lower use of preventive services, and poorer self-reported health, and that these patients were at increased risk for hospitalization and mortality (Baker, et al., 2007; Gazmararian, et al., 1999; Pepe & Chodzko-Zajko, 1997; Wolf, et al., 2005). No studies could be found in which the relationship between working memory capacity, health literacy and information recall was examined. This study proposes to address this gap in the literature.

An important consideration in this population is that the problems associated with low health literacy may be exacerbated by deficits in working memory. The ability to recall health information can become complicated when individuals experience age-related cognitive declines, which may contribute to older adults’ inability to understand health messages. Therefore, the focus of this study was older adults’ ability to successfully recall health information about the warning signs of stroke as related to working memory capacity and health literacy. Personal factors will be examined as well for their potential relationship to the study variables.

Personal Factors

There are several personal factors that may contribute to an older adult’s ability to successfully recall health information such as the warning signs of stroke. Advancing age is linked to declines in working memory capacity. Several research studies suggest that age is an independent risk factor for changes in working memory and theorize that these deficits decline linearly with age (Cowan, 2005; Craik, Morris, Gick, Vallar, & Shallice, 1990; Hakansson, et al., 2009). Sensory deficits in vision have been attributed to poorer understanding and subsequently poor recall in the elderly (Raji, et al., 2005). Changes in visual acuity can contribute to poor
comprehension of information related to the older adults’ inability to read printed health information. Educational attainment has been linked to low levels of health literacy among the elderly and has been shown to contribute to poor health outcomes in this population (Federman, Sano, Wolf, Siu, & Halm, 2009; Manly, Touradji, Tang, & Stern, 2003). Economic factors such as poverty and lack of access to resources are linked to poor health literacy and earlier declines in cognitive functioning in the elderly. Chronic health conditions in the aged and the use of multiple prescription medications are also linked to declines in memory and poor health literacy and may contribute to the ability to successfully recall printed health information.

**Theoretical Model**

Understanding the mechanisms that are associated with the recall of health information is an important consideration if older adults are to appropriately act on health messages. This investigation focused on the interaction between working memory capacity and health literacy in predicting recall of a health message concerning the warning signs of stroke in a sample of community dwelling older adults. The model postulates that there are two primary individual characteristics that may influence an older adult’s ability to recall a health message: working memory capacity and the degree of health literacy. The model also posits that there may be certain personal factors involved in the recall of health messages. The association of personal factors such as age, gender, marital status, living arrangement, educational attainment, socioeconomic status and type and number of chronic illnesses, number of prescriptions were also examined in relation to recall. The theoretical model was developed and based upon research examining cognitive aging, specifically working memory capacity, studies investigating health literacy and recall of health information. The purpose of the model is to provide a
framework for investigating the interaction between working memory capacity and health literacy and understanding the effect of these two factors on recall of health messages in the elderly. This model also considers that personal factors (e.g. education and chronic illness) are also associated with recall in the elderly.

Figure 1

*Model of Factors Influencing Recall of Health Messages in Older Adults*

Purpose of the Study
The purpose of this research study was to investigate the association between working memory capacity, health literacy, and recall of printed health information concerning the warning signs of stroke in community dwelling older adults. The participants’ recall of the warning signs of stroke were assessed by their ability to read a standardized information sheet published by the American Heart and Stroke Association and subsequently recall the information at completion of the study visit. The personal factors age, gender, marital status, living arrangements, educational attainment, socioeconomic status and type and number of chronic illness and number of prescription medications were examined.

Research Questions

To accomplish these purposes, the following research questions were addressed:

1) What are the relationships among the three key variables: working memory capacity, health literacy and recall of the five warning signs of stroke among community dwelling older adults?

2) Is there an influence of the interaction between working memory capacity and health literacy in predicting recall of the five warning signs of stroke among community dwelling older adults?

3) What are the relationships between the personal factors (age, gender, marital status, living arrangement, educational attainment, socioeconomic status and type and number of chronic illness, number of prescriptions) and the key variables (working memory capacity, health literacy) and recall of the five warning signs of stroke) among community dwelling older adults?

4) Which of the personal factors (age, gender, marital status, living arrangement,
educational attainment, socioeconomic status and type and number of chronic illness, number of prescriptions) taken together best explain the variance in recall of the five warning signs of stroke among community dwelling older adults?

5) What key variables and personal factors together best predict recall of the five warning signs of stroke among community dwelling older adults?

Definition of Terms

The following definitions will be used in this study:

*Older adults*’ are individuals who are age 65 years and older. The term older adult and elderly will be used interchangeably.

*Community-dwelling older adults* are those persons who are 65 years and older who are living independently in the community.

*Working memory capacity* is defined as the amount of information that an individual can hold in mind at any one time (Park & Schwartz, 2000). The term working memory and working memory capacity are used interchangeably in this study.

*Health literacy* is the degree to which individuals have the capacity to obtain, process, and understand basic health information and services needed to make appropriate health decisions (Speros, 2005).

*Recall* is defined as the mental ability to call back stored information freely.

*Encoding* is the processing of sensory input into one's memory.

*Memory* is defined as the cognitive ability to encode, store, retain and recall information (Craik & Salthouse, 2007).
Summary Chapter I

Cognitive processes are involved in the recall of health information. Recognizing the role of working memory among older adults in the recall of information could improve patient outcomes and decrease long term complications and cost because future health messages could be designed with these issues in mind. Poor health literacy among the elderly has been associated with increased morbidity and mortality in this population. The need to understand the factors that contribute to the recall of important health messages cannot be overemphasized. The older adult’s ability to manipulate information in working memory together with limitations in health literacy may seriously compromise the ability to recall important health information such as the warning signs of stroke in high risk populations. The results of this research aim to provide information about the interaction between working memory capacity and health literacy on older adults’ ability to recall of the warning signs of stroke. The findings from this study may assist future intervention studies to promote the effective design of health messages that benefit older adults’ recall of the warning signs of stroke.
CHAPTER II : LITERATURE REVIEW

Introduction

Remembering medical information is a prerequisite for symptom management and following through on recommended treatment plans. Research has independently established that in order to recall health information older adults need to rely on working memory and health literacy (Federman, et al., 2009; Grady & Craik, 2000). There are few studies to date that have investigated the associations between working memory capacity, health literacy and the recall of health information. The purpose of this study was to describe the relationship between the variables working memory capacity, health literacy and recall of the health message warning signs of stroke in a sample of community dwelling older adults. The supporting literature reviewed for this work has been compiled from studies on: 1) cognitive aging and working memory capacity; 2) health literacy; 3) recall; and 4) stroke in older adults. The review of literature is intended to provide a foundation for understanding the rationale for this study by integrating previous work that supports the proposed relationships between variables thought to influence the recall of a health message about the warning signs of stroke in older adults.

Recall

There are a series of steps that occur during the processing of information. Researchers theorize that information is synthesized in a series of cognitive steps that involve encoding, storage and retrieval (Craik, 2002). During this process, information is actively manipulated and stored as memory for future use. Initially information that has been either seen, heard, thought about, or felt can be transformed into a memory (Schacter, Addis, & Buckner, 2007). Content is temporarily stored in working memory where it goes through levels of processing beginning with shallow encoding as words are recognized, followed
by deep or elaborative encoding where meaning is formed (Craik & Bialystok, 2006). Elaborative encoding allows information to move from working memory into long-term memory through the construction of associations or the formation of links to prior knowledge. These connections act as ‘mental glue’ that gives meaning to the information and helps in the storage and retrieval process. The process of reading and retaining information involves the active and conscious manipulation of information to encode and store it in long-term memory. As information is processed internal cues are created that aide in future spontaneous recall of information. Storage is the retention of encoded information. Encoding and storage are necessary to acquire and retain information (Karpicke & Roediger, 2008). However stored information is only beneficial if it can be retrieved. The process of retrieving information from memory is referred to as recall (Karpicke & Roediger, 2008). The recall of a health message involves remembering information that has been either read or heard or thought about (Park & Liu, 2007). Retrieval is a crucial process in remembering, and without it we cannot access stored information. In the broadest sense, retrieval refers to the use of stored information.

Information that has been successfully stored in memory can be retrieved in a number of ways. Free recall occurs when information is retrieved without an external cue. Information is subjectively recalled using any strategy available. Recognition uses external clues or hints to help bring information into consciousness. Several factors have been shown to influence recall of information and these may be especially likely to affect older individuals and therefore influence their ability to successfully recall health a message.

In summary, the recall of health messages is necessary if older adults are to benefit from important health information. There are certain cognitive and physical processes that are needed in order to recall health messages such as the warning signs of stroke. The literature supports that with increasing
age, older adults experience cognitive and physical changes that affect the way they think and remember (Cabeza, Anderson, Locantore, & McIntosh, 2002; Cargin, Collie, Masters, & Maruff, 2008; Salthouse, 2003). Older adults may encounter trouble at any point in the process as information is presented, encoded, retained and retrieved. The understanding of the relationship among the key variables of working memory capacity, health literacy and recall of the printed health information concerning the warning signs of stroke may offer insight into factors that influence how older adults recall health information.

**Working Memory Capacity**

Memory is the ability to encode, store and recall information. Traditionally memory is divided into short term or conscious processing and long term storage. A contemporary model of conscious processing is working memory (WM) and is proposed as the site for the temporary storage and manipulation of information (Baddeley, 1992). There are two slave systems (phonological loop and visuo-spatial sketchpad) that provide the framework for the functioning of working memory. The model of working memory proposes that the central executive acts as a coordinator for the slave systems and is responsible for the control and regulation of cognitive processes (Baddeley, 2003). The central executive is primarily concerned with tasks involved in planning and decision making. The phonological or articulatory loop is occupied in the maintenance and rehearsal of verbal or sound information (Buchsbaum & D'Esposito, 2008). The model asserts that all auditory verbal information is automatically entered into the phonological store. The phonological store is believed to function as an ‘inner ear’ that remembers speech sounds in their temporal order while the articulatory loop functions as an ‘inner voice’ that repeats the series of words to prevent the decay of information (Baddeley,
The visuospatial sketchpad processes visual and spatial information and is assumed to hold all information about what we see. This slave system is thought to be the place for the temporary storage of visual and spatial information such as remembering the color or the location of objects in space (Zimmer, 2008). The final component of this system is the episodic buffer that works to combine all of the information between the two slave systems (Baddeley & Hitch, 1994). An assumption of this theory is that if two tasks simultaneously use the same component, they cannot be performed successfully together because of each slave system's limited capacity (Baddeley, 2000).

Figure 2

*Model of Working Memory*


Cognitive aging research supports that with increasing age, a linear decline occurs in the amount of information that can be held and manipulated in WM (Baddeley & Hitch, 1974; Bopp & Verhaeghen, 2005; Dixon, Backman, & Nilsson, 2004; Insel, Morrow, Brewer, & Figueredo, 2006; Jonides, et al., 2008; Light & Anderson, 1985). Declines in working memory have been implicated in the performance of complex cognitive tasks and researchers have adopted several complementary methods which have
been successful in demonstrating the importance of working memory in carrying out these behaviors (Miyake & Shah, 1999). One approach that has been used to examine the role of working memory in complex tasks from the perspective of individual differences is through the use of working memory span tasks as a research tool (such as reading and digits span) (Daneman & Carpenter, 1980; Engle, Cantor, & Carullo, 1992; Miyake & Shah, 1999; Salthouse, 1991). The purpose of span tasks are to simulate working memory demands that are experienced during the performance of complex cognitive tasks by placing simultaneous demands on both the processing and storage components of working memory (Lustig & Hasher, 2002).

Gilinsky and Judd (1994) looked at performance using working memory measures (i.e. reading span, digit span) in a cohort of young and old adults. A composite of working memory performance suggested a systematic decline in working memory with increasing age, with a slight decrement over each decade (Craik & Salthouse, 2000; Gilinsky & Judd, 1994). Similar results have been reported in research using simple span measures such as digit span and suggest that older adults appear to have a smaller memory span than do younger adults (Conway, et al., 2005; Engle, et al., 1992; Kemper & Sumner, 2001). Significant age differences are found in working memory when measured by tasks like reading span, listening span and operation span that require active processing of information while simultaneously buffering other information in working memory (Bopp & Verhaeghen, 2005; Kemper & Sumner, 2001; Soederberg, Cohen, & Wingfield, 2006). In addition, research connotes that individual differences in span are important predictors of performance on other tasks, including language comprehension and reasoning (Grady & Craik, 2000; Meguro, et al., 2000).

Older adults appear to have smaller span measures whether measured by simple or complex measures and are important predictors of performance (Craik & Salthouse, 2000). Further investigations
reveal that working memory capacity is not only a matter of span but also depends upon the complexities imposed by the simultaneous processing and storage of information. Working memory is thought to be both the site for the execution of these processes and the location where the products of these processes are stored (Baddeley & Hitch, 1974; Caplan & Waters, 1999). It has been proposed that working memory capacity plays a crucial role in reading comprehension (Daneman & Carpenter, 1980; Stine-Morrow, Soederberg Miller, Gagne, & Hertzog, 2008). Individual differences in reading comprehension may actually reflect differences in working memory capacity (Babcock & Salthouse, 1990; Dixon, et al., 2007). Working memory capacity differences have been used to explain individual differences in young populations and group differences between young and older adults in a range of tasks, including natural language use (i.e. comprehension, production, discourse recall, etc.), a wide variety of reasoning tasks, recognition of declarative memory, procedural errors, and skill acquisition (Bialystok & Craik, 2006; Craik & Salthouse, 2007).

There is little research on the influence of working memory declines in older adults in the context of medical information recall. Research investigating working memory and recall of medical information supports that increases in cognitive load or working memory resources has an adverse effect on recall (Morrell, Park, & Poon, 1989). Cognitive load theory posits that learning requires the development of schemas that connect information to long-term memory and that learning occurs when the load on working memory is kept to a minimum (Sweller, Chandler, Tierney, & Cooper, 1990). The learning of complex health information like the warning signs of stroke is considered to be effortful and dependent upon available working memory resources. A study investigating recall among older cancer patients learning concerning chemotherapy treatments reported that in general, older patients had difficulty remembering items related to their treatment plan shortly after a learning session (Jansen, et
al., 2008). Study authors attributed this deficit to the complexity of medical and treatment options that were provided to this cohort. Researchers examined the relationship between cognitive factors verbal fluency, memory and health literacy in a cohort of older adults’. The study found memory and verbal fluency to be associated with health literacy, independently of education and health status, even in those participants that demonstrated subtle cognitive dysfunction. Study recommendations concluded that reducing the cognitive burden of health information may improve the understanding of important health information (Federman, et al., 2009).

The relationship between working memory and recall of health information appears to be an important consideration when providing information to an older cohort. Cognitive changes that occur during normal aging may influence people’s ability to obtain and act on health information. The effect of cognitive aging may be more devastating for patients with poor health literacy who are likely to have fewer cognitive compensatory resources.

**Health Literacy**

An important component in the recall of health messages is literacy. The Institute of Medicine reported that nearly half of all American adults have difficulty understanding and using health information (Institute of Medicine, 2004). This finding is supported by the National Adult Literacy Survey (NALS) that was carried out to estimate the overall literacy of the adult population in the United States. The NALS reported that close to half of individuals older than 65 years of age scored in the lowest reading levels (NALS 1 and 2) and are considered functionally illiterate (Wolf, et al., 2005). The NALS report identified 44 million adult Americans who could not read or write sufficiently to carry out routine daily activities (Gazmararian, et al., 1999). Literacy is an important skill because it allows individuals to communicate and function in society. Of particular relevance to the present study, poor
literacy in older adults can have serious implications in the understanding of health information. The term “health literacy” refers to reading and understanding in the context of health care (Schwartzberg, VanGeest, & Wang, 2005). The concept of health literacy is defined as the degree to which individuals have the capacity to obtain, process, and understand basic health information and services needed to make appropriate health decisions (US Department of Health and Human Services, 2000). Health literacy is more than a measurement of reading skills; it includes writing, listening, speaking, arithmetic, and conceptual knowledge (Institute of Medicine, 2004).

Research investigations have focused on multiple aspects of health literacy in the older adult. To date no research studies specifically investigating the relationship between cognitive aging, low health literacy and the older adult’s ability to successfully recall health related information such as the warning signs of stroke. However, several studies support the notion that health literacy is an important determinant of various health outcomes (Cutilli, 2007; Gazmararian, Williams, Peel, & Baker, 2003; Mancuso & Rincon, 2006; Morrow, et al., 2006; Wolf, et al., 2007). Several population based studies have sought to understand the prevalence of low health literacy in community dwelling older adults (Carmona, 2006; Institute of Medicine, 2004; Literacy, 1999; Pleasant & Kuruvilla, 2008) and studies have reported that inadequate health literacy was independently associated with poorer physical and mental health and the lower use of health services (Scott, Gazmararian, Williams, & Baker, 2002; Wolf, et al., 2005, 2007).

The relationship of cognitive performance and health literacy were investigated using the Mini Mental State Examination (MMSE). The study reported a positive correlation between MMSE scores and measures of health literacy (Shortened Test of Functional Health Literacy in
However, these results were attributed to a higher prevalence of dementia in individuals with less education in the population and further research was recommended (Baker, et al., 2002; Parker, Baker, Williams, & Nurss, 1995). Federman and colleagues (2009) investigated the relationship between health literacy and cognitive performance using immediate and delayed recall (Wechsler Memory Scale II), verbal fluency measures (Animal Naming) and global cognitive functioning (MMSE) and found that memory and verbal fluency were strongly associated with health literacy skills among older adults (Federman, et al., 2009).

Health literacy has been found to be generally poorer with lower reading skills among older age groups, which is particularly problematic due to this groups’ high prevalence of chronic illness (Williams, Baker, Parker, & Nurss, 1998). Several studies have focused on the prevalence of low health literacy among community dwelling Medicare enrollees (Gazmararian, et al., 1999; Williams, et al., 1995; Wolf, et al., 2007). These studies found that elderly Medicare enrollees may not have the literacy skills necessary to function adequately in the health care environment. In addition low health literacy may impair elderly patients understanding of health messages and limit their ability to care for their medical problems. The comprehension of prescription warning labels in a cohort of older adults found that approximately one-third of patients were reading below the 6th grade level which is considered low literacy and that patients with low literacy had difficulty understanding prescription warning labels (Davis, et al., 2006b).

Morrow and colleagues (2006) investigated the relationship between health literacy, general cognitive ability, sensory abilities, and demographic variables in a community sample of middle-aged and older adults. Health literacy was measured using the Short Test of Functional Health Literacy in Adults (S-TOFHLA). Results indicated that participants who were older, less
educated, male, and African American, and who had several comorbid conditions, or who scored lower on all cognitive measures also scored lower on the health literacy measure. A hierarchical linear regression analysis demonstrated that education and cognitive ability were independently associated with the S-TOFHLA measure and explained age differences in health literacy (Morrow, et al., 2006).

Poor health literacy has been associated with low socioeconomic status, increased comorbidities, and limited access to health care in an aging cohort (Sudore, et al., 2006). Of importance to this study is the association of poor memory and health literacy among older adults in particular the recall of important health information. Research on health literacy suggests that it may be an independent risk factor for health disparities among older adults and that the relationship between cognition and health literacy warrants further investigation.

**Personal Factors**

Research investigating cognitive aging support that certain personal factors may affect recall among older adults. These factors may present independent barriers that may interfere with the success of remembering health messages such as the warning signs of stroke.

**Age**

Research has established advanced age as an independent risk factor for declines in working memory capacity. A number of studies support that performance involving working memory tasks decline gradually from early adulthood on (Craik, et al., 1990; Meguro, et al., 2000; Salthouse, 1994). Older adults experience age related declines in their ability to hold information in mind as they manipulate and integrate moderate amounts of information over
short time spans. Advanced age is considered an independent factor that contributes to the older adults’ ability to successfully recall important health information.

*Sensory Deficits*

Visual acuity is an important consideration in the accurate interpretation of health messages. The eyesight of most older individuals worsens, and visual acuity or the ability to focus is reduced (Lee, et al., 2007). Sensory decline occurs with increasing age and poor visual acuity can interfere with the older adult’s ability to correctly interpret information and subsequent recall (Brennan, Su, & Horowitz, 2006; Chia, et al., 2006). Age related sensory changes in visual acuity may influence the older adults’ ability to recall health information simply because they cannot adequately read the presented material (Chia, et al., 2006; Morrow, et al., 2006). Visual changes have been shown to influence reading ability and activities of daily living and have been associated with poor health outcomes and increased mortality (Freeman, Egleston, West, Bandeen-Roche, & Rubin, 2005; Knudtson, Klein, Klein, Cruickshanks, & Lee, 2005). An individuals’ ability to adequately see should be considered when presenting older adults with written health information.

*Depression*

Psychological factors such as a depressed affect have been shown to alter the functioning of memory among older adults (Blazer, Landerman, Hays, Simonsick, & Saunders, 1998; Sachs-Ericsson, Plant, & Blazer, 2005). Depression is associated with poor concentration and attention that contributes to deficits in memory (Weiss, Francis, Senf, Heist, & Hargraves, 2006). Research investigating older adults diagnosed with depression supports a slowing of cognitive functioning that operate as a barrier to learning and remembering new information. Older adults
experience an increased incidence of depression that interferes with activities of daily living and the execution of cognitive tasks (Steffens, Fisher, Langa, Potter, & Plassman, 2009).

Education and Socioeconomic Factors

Researchers have described associations between education, income, morbidity and mortality among the elderly (Byrd, Fletcher, & Menifield, 2007; Kahn & Fazio, 2005). Older adults with low educational attainment and lower reading levels experience cognitive declines (Baker, et al., 2000a). Poor education is associated with low health literacy among older adults (Cutilli, 2007). Research investigating economic status among the elderly suggests that nearly one-half of all Americans age 60 to 90 will experience at least one year of living near or below the poverty line during their elderly life span, and the percentage increases sharply for those individuals who are African American, not married and/or have less than 12 years of education (Hu, 2007; Manly, et al., 2003; Rank & Hirschl, 1999). Limited education and low economic status has been associated with poor memory and may result in poorer health outcomes in vulnerable populations (Bramnick, 2005; Byrd, et al., 2007; Harris, 2001).

Chronic Illness and Prescription Medications

The elderly experience the highest proportion of chronic illness of any group aged 65 and older and often experience multiple comorbidities necessitating the use of multiple prescription medications (Bennett, Chen, Soroui, & White, 2009). Chronic health conditions have been linked to cognitive decline in the elderly (Ebady, Arami, & Shafigh, 2008; Maggi, et al., 2009). Polypharmacy is common among the elderly and has been shown to contribute to changes in cognition and poor functional status in this population (Hilmer & Gnjidic, 2008).

Summary Chapter II
Aging is associated with declines in cognition and low health literacy (Baker, et al., 2000a; Manly, et al., 2003). Working memory provides temporary storage and manipulation of the information necessary for such complex cognitive tasks as language comprehension, learning, and reasoning (Baddeley, 1992). Research on cognitive aging supports the view that as we age, aspects of our cognitive processes or working memory becomes less efficient (Bialystok & Craik, 2006; Craik & Salthouse, 2007). Health literacy is the degree to which individuals have the capacity to obtain, process, and understand basic health information and services needed to make appropriate health decisions. Older adults have been shown to experience low levels of health literacy (Cutilli, 2007). The combination of deficits in working memory and low health literacy may contribute to the older adults’ ability to successfully obtain, understand and manage health messages. The literature suggests that declines in working memory as demonstrated by the limited capacity to retain information together with low health literacy may influence older adults’ ability to successfully obtain, remember and understand the information provided in a health message. To date there is no research that has investigated the interaction between working memory capacity and health literacy on recall of health information. This study will address the existing gap in the literature on the association of working memory and health literacy and provide information on the associations of these two key factors and how they may affect community dwelling older adults’ ability to successfully recall printed health information.
CHAPTER III: METHODOLOGY

Introduction

The purpose of this research study was to investigate the association between working memory capacity, health literacy, and recall of the warning signs of stroke in a cohort of community dwelling older adults. This chapter discusses the research methodology used in the study, including design, sample and setting, variables studied, measures, procedures, data management, analysis plan and human subject protection.

Research Design

A nonexperimental design was selected to answer the research questions. The design was selected to identify associations among the studied variables without making causal statements (Polit & Beck, 2004).

Participants recruited for this study were screened for impaired near vision, symptoms of dementia and depression. Study subjects who were found to have adequate near vision, no signs of dementia, or depression were enrolled in the study and appointments were made to complete study participation.

Setting

This study utilized two recruitment sites, an urban community Senior Center located on Long Island, New York and one Retirement Residence located in the tri-state (New York, New Jersey and Connecticut) area. The Senior Center reported a membership of approximately 200 community dwelling older adults and the Retirement Residence housed 174 seniors.
Sample

A convenience sample of men and women ages 65 and older were recruited for this study. The Senior Center and Retirement Residence were selected to allow for access to the target population.

*Inclusion /Exclusion Criteria*

To be included in this study, study participants were required to be age 65 or older, and speak and read English. The following were criteria for exclusion in this study: symptoms of depression, as indicated by a score of greater than 6 on the Short Form of the Geriatric Depression Scale (GDS); signs of dementia as indicated by a score < 24 on the Folstein Mini-Mental State Examination (MMSE): and inadequate near vision as measured by visual screening using the standardized Rosenbaum Pocket screen equal to or worse than 20/50. Study participants who did not meet inclusion criteria and were excluded from participating in this study were given a standard referral list of services that identified appropriate community resources, which could be easily accessed.

*Sample Size*

The procedure of a power analysis assures that the selected sample size is sufficiently large enough to be able to obtain statistical significance (Polit & Beck, 2004). Power analysis indicated that 59 participants would achieve 80% power at a significance level (alpha) of 0.05. The sample size was calculated to detect a moderate degree of association in regression analysis.

*Sampling Plan*

A convenience sampling plan was selected for this study. Facility staff at approved recruitment sites obtained verbal permission from potential participants for the researcher to
discuss the study. The researcher approached potential participants, described the purpose of the study, the inclusion/exclusion criteria, and the informed consent procedure, and then written consent was obtained.

Measures

The following screening measures were completed once written informed consent was obtained to determine participants’ eligibility for this study: Rosenbaum Pocket Vision Screen, Mini-Mental State Examination, and the Geriatric Depression Scale Short Form.

Screening Measures

*Rosenbaum Pocket Vision Screen*

Older adults experience changes in visual acuity related to age and chronic illnesses such as diabetes (Freeman, et al., 2005). Near vision is important to assure the ability to see and read the brochure indicating the 5 warning signs of stroke. Near vision was assessed using the Rosenbaum Pocket Vision Screen (Horton & Jones, 1997). The Rosenbaum Pocket Vision Screen is the most widely used handheld card for measuring near visual acuity and is scaled to the Snellen system. Subjects are permitted to wear corrective lenses during the test. The Rosenbaum test screens for near vision and is performed by asking the individual to read the smallest line possible on a pre-printed card held 14 inches away. The procedure is conducted for each eye while the subject covers the opposite eye with the opposite hand. A standardized Rosenbaum test was obtained for use in this study and used to screen all participants. Participants for who near vision was more than 20/50 were excluded from this study.
**Mini-Mental State Examination**

The Mini-Mental State Examination is a 30-point screening test that is used to evaluate cognitive function and has been found to be a valid measure for screening for symptoms of dementia in a geriatric population (Folstein, Folstein, & McHugh, 1975). The test has been used extensively in the clinical settings and in research. The measure takes approximately 5-10 minutes to complete. The MMSE provides an indication of various cognitive processes including orientation, memory and verbal and motor skills (Crum, Anthony, Bassett, & Folstein, 1993; Folstein, et al., 1975). The test items include orientation to time and place; immediate and delayed recall of three items (apple, table, penny); spelling of the word ‘WORLD’ backwards; repetition of a phrase (no if ands or buts); writing a complete sentence; following a three step command (paper folding); and copying of two intersecting pentagons. Scores on the test range from 0 to 30, with scores of 24 or higher indicating no symptoms of dementia. Participants were included in this study if they achieved a score of 24 or higher on the test. Scores 23 and below are indicative of cognitive impairment and is part of the study exclusion criteria. Test-retest reliability has been established for the MMSE at r = .83 to .90 (Clark, et al., 1999).

**Geriatric Depression Scale Short Form**

Geriatric Depression Scale-Short Form was used to screen for depression in this study (Yesavage, et al., 1983). The GDS-SF is a 15-item tool that has been validated in a geriatric population and has been used extensively both in the clinical setting and in research (Brown & Schinka, 2005; Crawford & Robinson, 2008; Friedman, Heisel, & Delavan, 2005). The GDS-SF is a brief questionnaire, with no time limitations, in which participants are asked to respond to the questions by answering “yes” or “no” in reference to how they feel on the day of
administration. Scores of 0 - 5 are considered normal, though 6 - 15 indicate that the individual may be depressed and a more formal clinical evaluation is needed. Participants that were determined to demonstrate symptoms of depression by a score of greater than 5 on the GDS-SF were excluded from the study and referred to appropriate community resources. The GDS-SF demonstrates a test-retest reliability .85 and internal consistency = .94 (Friedman, et al., 2005).

Study Measures

Health Message: Warning Signs of Stroke

The “warning signs of stroke” was selected as the health message used as the indicator for the ability to recall a health message. Stroke is an international health challenge and the American Heart Association has established a national campaign to bring awareness to the general public. To achieve this goal the association publishes several public service brochures and information sheets that discuss stroke and its warning signs. The information sheet selected was “Let’s Talk About Stroke, TIA and Warning Signs” (American Heart & Stroke Association, 2007). The two page information sheet discusses stroke, transient ischemic attack and the five warning signs of stroke. The five warning signs of stroke provide key information about symptoms that can occur prior to the onset of a complete stroke. The five warning signs of stroke include: (1) sudden numbness or weakness of the face, arm, leg, especially on one side of the body; (2) sudden confusion, trouble speaking or understanding; (3) sudden trouble seeing in one or both eyes; (4) sudden trouble walking, dizziness, loss of balance or coordination; (5) sudden severe headache with no known cause (American Heart & Stroke Association, 2007). Research has established that experiencing any of the five warning signs of stroke is a medical emergency and individuals should seek immediate medical attention (Dearborn & McCullough, 2009;
Kothari, et al., 1997; Nicol & Thrift, 2005). Participants were given this information sheet to read with no time restrictions and were given a copy of the information sheet to take home at completion of the study visit. The researcher was available to answer any questions pertaining to the information sheet that study participants expressed during data collection.

Demographic and Medical Variables

A demographic and medical questionnaire was completed once participants were recruited into the study and was used to describe the study sample. The researcher collected the demographic variables using an interview process that was guided by the questionnaire. The selected variables used to describe the study sample were age (date of birth), gender (male, female), marital status (married, divorced, single, widow), education (years of schooling), living arrangements (alone, number of people in household), income (income exceeds expenses, income meets expenses, income barely meets expenses, income does not meet expenses). The demographic variable education was selected because low educational attainment is associated with cognitive decline and low health literacy in the elderly (Federman, et al., 2009).

The medical variables that were collected to describe the study sample included number of chronic illnesses, type of chronic illness(s), and number of medications prescribed. The type of chronic illness was described in this study because specific medical conditions, for example type two diabetes mellitus have been associated with cognitive impairment (Luchsinger, et al., 2007).

Wechsler Adult Intelligence Scale 3rd Edition (WAIS-III)-Working Memory Index (WMI)

Working memory capacity was measured using the Wechsler Adult Intelligence Scale-III, Working Memory Index, which is composed of a triad of tests: Mental Arithmetic, Digits
Span Forward and Digits Span Backward, and Letter-Number Sequencing (WAIS-III, 1997). The WMI assesses the individual’s ability to memorize new information, hold it in working memory, concentrate, and manipulate that information (Kaufman & Lichtenberger, 1999). Working memory is an active process needed for cognitive flexibility and planning ability, as well as learning new information and self-monitoring. Intercorrelations among these specific subtests are reported in the WAIS-III-WMS-III Technical Manual (Wechsler, 1997a), and range between .52 and .70 (Wechsler, 1997).

*Mental Arithmetic*

The Mental Arithmetic subtest utilizes a series of arithmetic word problems that are solved mentally, without the use of pencil or paper, and participants are required to respond orally within a specified time limit. The subtest is composed of 20 items beginning with three practice problems. The time to complete the arithmetic word problems increases with the complexity of the equations and is recorded. Arithmetic requires manipulation and spatial visualization in addition to knowledge of basic computational facts. The total maximum score for the Mental Arithmetic subtest is 22 points. The Mental Arithmetic subtest has a reported test-retest reliability of .86.

*Digit Span Forward and Digit Span Backward*

The Digit Span test measure span of immediate verbal recall, and is a measure of working memory capacity and attention (Lezak, 2004). Digit Span, the second subtest in the WMI, is composed of two tasks; Digits Forward and Digits Backward. Digits Forward and Digits Backward are administered independently of each other. On both tasks the examiner reads a series of number sequences to the examinee. The participant is asked to repeat strings of numbers
back to the examiner verbatim for Digit Span Forward, and in reverse order for Digit Span Backward. The digits are presented verbally at a rate of one digit per second. Two trials are presented at each digit load level, and after successful completion of two trials at the two-digit level, the next trial consists of three digits. With each subsequent trial, the number of digits increases. The score is the total number of trials that the participant was able to recall correctly. The repetition of digits forward is considered an automatic task and does not place a significant strain on working memory whereas the digits backward portion of the test requires visualization and manipulation (Kaufman & Lichtenberger, 1999). A higher score represents better working memory capacity. The raw scores obtained from the Digits Forward and Digits Backward combined creates the Digit Span raw score composite used as a measure of working memory performance. The Digit Span Forward and Backwards subtest from the WMI is considered a reliable measure of working memory with a test-retest reliability of .83 as a composite score and has been used in research with a variety of populations to provide an index of working memory capacity (Bopp & Verhaeghen, 2005).

**Letter-Number Sequencing**

The Letter-Number Sequencing subtest measures attention and working memory by using auditory stimuli (Wechsler, 1997). The test has five practice trials; however the subtest is administered even if the examinee fails to complete all of the practice trials. The test consists of letters and numbers that are out of sequence, for example 6-R-2-F. The examinee is asked to repeat the numbers in order first and then the letters in alphabetical order, for example 2-6-F-R. The examinee is given credit if the letters are said before the numbers, as long as they are in the
correct sequence. The Letter-Number sequencing subtest has a reported test-retest reliability of .75 (Kaufman & Lichtenberger, 1999).

**Health Literacy**

*Short Test of Functional Health Literacy in Adults*

Health literacy was measured using the Short Test of Functional Health Literacy in Adults (S-TOFHLA) (Parker, et al., 1995). The S-TOFHLA measures the ability to read passages using printed patient material routinely found in healthcare settings (e.g. how to prepare for a diagnostic procedure). The S-TOFHLA does not have a numeracy section. The instrument is a timed test and participants are allowed up to 7 minutes to complete it. The S-TOFHLA was developed to assist healthcare professionals determine patients’ health literacy in the clinical setting and has been used extensively in ethnically diverse populations of older adults with varied socioeconomic status (Baker, Williams, Parker, Gazmararian, & Nurss, 1999). The S-TOFHLA measure includes two kinds of health passages; X-ray preparation and Medicaid rights and responsibilities. The measure is a 36-item cloze test. A cloze test is a fill-in, multiple choice test that lists possible choices a through d. The test requires participants to read a sentence and answer questions that measure their understanding of the material. Participants are required to “fill in the blank” using a word from a list of options. The S-TOFHLA scores range from 0-36, with higher scores indicating better health literacy. Scores are divided into three levels of health literacy: adequate level of health literacy or can read and interpret most health texts (23-36); marginal health literacy or has difficulty reading and interpreting health texts (17-22); and inadequate health literacy or unable to read and interpret health texts (0-16) (Baker, et al., 1999). The S-TOFHLA is a widely used tool since the 1980s with previous studies documenting the
reliability of the test at 0.97 (Baker, et al., 1999). The test is shown to have high internal consistency (Cronbach’s alpha = 0.98 for all items combined) and concurrent validity ($r = 0.91$).

Data Collection Procedure

**Overview**

A letter describing the study and reasons for seeking voluntary participation was sent to directors of several community Senior Centers and Retirement Residences. The facilities that responded positively were identified to the University of Arizona Institutional Review Board and utilized as recruitment sites. Flyers announcing the study were distributed and posted in the two facilities that participated as recruitment sites for this research study two weeks prior to data collection. A convenience sample of participants was recruited during a six month period of time. The study was introduced to potential participants by saying that this researcher wanted to find out what health information is recalled by older individuals and what was forgotten, with the goal of helping to develop better ways of communicating health messages for older adults in the future. The concepts in the theoretical model (Figure 1.) reflect working memory capacity, health literacy and the outcome of recall as measured by the warning signs of stroke. Data collection and testing took place at the selected facilities in a private area designated by the facility. Participation in this study took approximately one hour to complete and this researcher tested all study participants individually. No financial compensation was offered in this study.

Study participants were formally introduced to this study during an oral informational session that was approved by the facility administrative directors. A recruitment script (Appendix B) approved by the University of Arizona Institutional Review Board was read during the informational session. The presentation was followed by a brief question and answer session,
and individuals who expressed interest in this study were given the opportunity to sign up for a study visit. Contact cards with the researcher’s telephone number were distributed at the end of the session and all interested study participants were called within a two-week time frame for a screening visit.

**Screening**

Participants in this study were informed of their rights as human subjects and were given informed consent to read and sign (Appendix C). During the informed consent process participants were told that they could withdraw participation at any point in the study without consequence. A unique numerical identifier was assigned to all study participants to protect their identity. Participants were screened for study inclusion and exclusion criteria (visual acuity, cognitive impairment, and depression) once informed consent was obtained.

*Rosenbaum Test.* The researcher screened for visual acuity using the Rosenbaum Pocket Vision Screen (Horton & Jones, 1997). Study participants that achieved below 20/50 were excluded from the study. Four participants did not meet vision screen criteria and were excluded from the study. The researcher explained why they could not continue with study participation and were given a referral list for follow-up vision services.

*Mini-Mental State Examination.* The MMSE was used to screen for cognitive impairment prior to the start of testing (Folstein, et al., 1975). Participants who scored 23 or lower (indicative of cognitive impairment) were excluded from the study. Two participants were excluded and the researcher explained the reason for exclusion and they were given a list of community resources as a referral source for further cognitive evaluation.
Geriatric Depression Scale-Short Form. All study participants were screened for depression using the GDS-SF. This researcher administered the instrument and results were recorded as per instructions on a pre-printed form. Subjects who scored greater than 5 on a 0-15 scale were determined to be at risk for depression and were not eligible to participate in this study.

Demographic and Medical Variables

The researcher completed a demographic questionnaire and information was recorded on a pre-printed form (Appendix A). The variables collected were date of birth (age), gender (male, female), marital status (married, divorced, single, widow), education (years of schooling), living arrangements (alone, number of people in household), and income (income exceeds expenses, income meets expenses, income barely meets expenses, income does not meet expenses). The medical variables included type and number of chronic medical illnesses and number of prescription medications that were taken on a regular basis.

Learning Session: Health Message

All study participants were asked to read a two page information sheet “Let’s Talk About Stroke, TIA and Warning Signs” (Appendix A) published by the American Heart Association for the general population. The information sheet discusses stroke, transient ischemic attack and lists the five warning signs of stroke as well as what actions should be taken if a person experiences any of the warning signs. Participants were given as much time as needed to read the information sheet, and ask follow-up questions and; upon completion, information sheets were collected. Participants in this study were not told that they would be asked to recall the health message
referencing the warning signs of stroke at the end of the study visit. The information sheet was returned to each study participant at the conclusion of the study.

Working Memory Index

*Mental Arithmetic*

The WMI was administered to each study subject and responses were recorded on a pre-printed form prepared by the researcher. Three arithmetic practice trials using red painted blocks were presented to allow participants to practice mental calculations followed by one practice word problem. The arithmetic response and completion time was recorded for each practice trial and arithmetic problem. Participants were not permitted to use paper and pencil during calculations but were allowed to verbally work through the calculations if needed.

*Digits Forward and Digits Backward*

The Digit Span test is composed of two tasks: Digits Forward and Digits Backward. The Digits Forward test was administered first beginning with a trial of two digits (e.g. 1-7). The researcher read a series of number sequences to the examinee and the examinee was asked to repeat them in the same order presented. The sequences of numbers increased after each set of two trials. The scores were recorded as 0 (missed trial) or 1 (correct response) with a total of eight trials and a maximum score of 16. The test was discontinued after a score of 0 on both trials of any one item. The Digits Backward test was administered and scored in the same manner as Digits Forward except the examinee was required to repeat the number sequence in reverse order with a total of seven trials and a maximum score of 14. At the completion of the tests, a composite score of the raw scores, from the Digits Forward and Digits Backward subtests was created with a maximum score of 30.
**Letter-Number Sequencing**

The researcher administered the Letter-Number-Sequencing test beginning with five practice trials. The subtest was administered even if the participant failed all five of the practice trials. The subtest has seven trial sections with three trials in each section with a maximum score of 21. The subtest was discontinued after scores of 0 were achieved on all three trials of an item.

**Health Literacy**

*Short Test of Functional Health Literacy in Adults*

The S-TOFHLA was administered to all study participants. The participants were given the reading comprehension passages with an oral explanation that the reading comprehension exercise focused on medical instructions that are typically seen around the medical or hospital setting. Participants were told that the goal of this test is to select which word completes the sentence and to circle the letter in front of the word they chose. They were asked to read each of the two passages and when they came upon a blank where a word was missing to choose one of the 4 possible words that could fill in the blank. Participants were told that once they had made a selection to continue on to the next sentence until they were finished. Subjects were given a time limit of seven minutes to complete the S-TOFHLA.

**Recall**

Recent memory was tested upon completion of all questionnaires and study measures. There was approximately a 90 minute time frame that had elapsed from when participants were given the “Let’s Talk About Stroke” information sheet to read and when they were asked to recall the five warning signs of stroke. Participants were given a piece of paper and asked the question “What are the five warning signs of stroke?” Participants were asked to down in any
order the five warning signs of stroke that they had read at the beginning of the study session. Participants were not given a time limit to complete the task. Cues were not given at any point during the recall portion of the study. All response sheets were collected upon completion and participants were given the American Heart Association information sheet for future reference. Study responses were coded as correct if they contained the key words listed on the information sheet, for example weakness.

The five warning signs to be recalled were:

- Sudden numbness or weakness of the face, arm, or leg, especially on one side of the body.
- Sudden confusion, trouble speaking or understanding.
- Sudden trouble seeing in one or both eyes.
- Sudden trouble walking, dizziness, loss of balance or coordination.
- Sudden severe headache with no known cause.

Participants received credit for the use of descriptive words that were closely associated with the key phrases that are published by the American Heart Association. The descriptive phrases accepted were: loss of feeling, extremity weakness, problems walking, blurred vision, slurred speech, and migraine.

*Data Analysis Plan*

All data collection and data entry was performed by the researcher for this study. Participant data was scored at the completion of the study visit and entered on an individual data entry sheet that was identified by subject number only. All data was cross checked for accuracy with the original study data and then entered into the Statistical Package for Social Sciences.
software (SPSS, version 14.0; 2005). Data was further checked against the individual worksheets and the SPSS database to ensure accuracy.

Descriptive statistics were used to describe and synthesize the demographic and medical variables. Frequency distributions were used to organize and summarize the data. Univariate analysis was selected to examine the variability of the data, and characterize each of the variables separately. To test the hypothesis of association bivariate analysis was used to examine the relationship between each independent variable and each dependent variable. This analysis was used to describe the variables individually and any patterns of response to the variable. Frequency distributions were obtained to aide in the systematic analysis of data.

Multiple regression analysis was the statistical method selected to explain the relationships among two or more predictor variables on the dependent variable (Trochim, 2005). Regression analysis was used to investigate the relationships among the independent variables working memory capacity and health literacy and the dependent variable recall.

Human Subjects Protection

Study approval was granted from the Institutional Review Board (IRB) of the University of Arizona prior to the onset of recruitment. A written letter of approval to conduct the study was obtained from each of the two participating recruitment sites, a Senior Center and a Retirement Residence. All participants were assured that participation in this study was voluntary and that they were free to withdraw from the study at any point in time without penalty or repercussions.

Security of Study Materials

Participants were assured that all study information collected was confidential and that all study related materials and data were identified by number only; no identifying personal
information was collected. All data was kept in a locked cabinet in the researcher’s office and electronic data was kept on a password protected computer. A master list of the participants’ names with the corresponding code number was kept for references purposes in a locked cabinet in a separate location. Participants of this study did not receive monetary compensation. The participants took approximately 60 minutes to complete the consenting procedure, questionnaires and instruments. Participants were informed that they could take breaks when needed.

Potential Risks

Minimal risks were associated with the participation in this study. Recognizing a slight risk that some questions may upset participants when responding to items in the study instruments, the researcher conducted all interviews in a private location within the approved recruitment facility to minimize any distress and/or discomfort or potential embarrassment of study participants.

Summary of Chapter III

The purpose of this study was to describe and document the relationship of the variables working memory capacity, health literacy and the recall of the five warning signs of stroke after reading a standard information sheet published by the American Heart and Stroke Association. A nonexperimental design was used to investigate the relationship among the key predictor variables (working memory and health literacy) and the dependent variable (recall). A significant limitation of this methodology is that no causality can be inferred and preexisting differences may offer a plausible alternative explanation for any group differences on the dependent variable (Polit & Beck, 2004).
Participants for this study were recruited from one of two IRB approved recruitment sites that serviced community dwelling older adults age 65 and older located in the Tri-State area. An informational session was held at each of the approved recruitment sites and participants were invited to sign up for the research study. All study participants were informed of human rights protections and written informed consent was obtained. Participants were initially screened for inclusion/exclusion criteria prior to beginning the study. Participants who did not meet criteria were informed and given a referral sheet listing the appropriate community resource. All study measures were collected and study data stored in a locked file cabinet in the researchers office.

Descriptive statistics were used to characterize the study variables. Multiple regression analysis was used to answer the research questions and to describe relationships among the key variables under investigation in this study.
CHAPTER IV: DATA ANALYSIS AND RESULTS

Introduction

The results of data analysis are presented in this chapter. The purpose of this research study was to investigate the association between working memory capacity, health literacy, and recall of printed health information concerning the five warning signs of stroke in a cohort of community dwelling older adults. The analysis was performed using the Predictive Analytics Software (PASW, Statistics 18; 2009) and a p-value of <0.05 was the criterion selected to determine statistical significance.

Descriptive Analysis

Univariate analysis was used to explore each variable in the data set separately, and to examine the range and the central tendency of the values. This method allows for the description of sample characteristics (Howell, 2008). Histograms were constructed and inspected to test for the normal distribution of each variable.

Fifty-six participants were recruited for this study. The participants were asked to complete a short demographic questionnaire at the onset of the study. These variables included personal and medical information. One of the criteria for being included in the study was age of the participant. Participants had to be at least 65 years of age and there were no maximum age criteria that would limit inclusion. There were 17 males (30%) and 39 females (70%) who were between the ages of 68 and 99 years with a mean age of 80.4 years (SD = 7.95). In this study gender was coded as 1 = male, 2 = female. All participants in this study self-identified as Caucasian (100%), and 39 were widowed (69.6%), 5 were divorced (8.9%), 9 married (16.1%), and 3 were single (5.4%). A very small number of participants had not finished high school (n=4,
7.1%) whereas 50% of participants completed at least some college (n=28). The largest group of the subjects (n=24) were those who completed high school (42.9%). The mean educational level across the entire sample was 14.2 years (SD = 3.46).

Table 1

Mean, Standard Error, and Range for Demographic and Relevant Variables

<table>
<thead>
<tr>
<th></th>
<th>Mean (SE)</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age in years</td>
<td>80.4 (1.063)</td>
<td>68 – 99</td>
</tr>
<tr>
<td>Education in years</td>
<td>14.2 (0.46)</td>
<td>8 – 22</td>
</tr>
</tbody>
</table>

Note: SE-standard error

The participants were asked to indicate their living arrangements: alone or with family/companion. Thirty-seven (66%) of the participants indicated that they lived alone and 19 (33.9%) were living with a family member or companion. Most of the participants were not working (80.4%) with the remaining 11 (19.6%) working. Data collected on economic status focused on the participants’ ability to meet their monthly expenses. Eleven (19.6%) reported that their income exceeded their expenses, 32 (57.1%) participants reported that their income met their expenses, 9 (16.1%) indicated that their income barely met their expenses, and 4 (7.1%) could not meet their expenses.

The medical information collected concerned the number and type of chronic health conditions, and whether or not participants took prescription medications. Fifty-one of participants in this study experienced comorbid health conditions. The number of comorbid conditions ranged from 0 to 4 with a mean of 1.8 (SD = 1.05). Fifty-two (92.9%) of the participants were taking prescription medications and 4 (7.1%) reported that they were not taking prescription medications with the mean number of medications of 5.6 (SD = 3.33).
There was no missing data for participants in this study. Additional relevant variables are further described in tabular format (Table 2).

**Table 2**

<table>
<thead>
<tr>
<th>Other Relevant Variables of Interest</th>
<th>N (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heart Disease</td>
<td>36 (64.3%)</td>
</tr>
<tr>
<td>Diabetes</td>
<td>8 (14.3%)</td>
</tr>
<tr>
<td>Cancer</td>
<td>8 (14.3%)</td>
</tr>
<tr>
<td>Gastrointestinal Disorders</td>
<td>5 (8.9%)</td>
</tr>
<tr>
<td>Other</td>
<td>24 (42.9%)</td>
</tr>
</tbody>
</table>

Note: N=56

Participants in this study were screened using the MMSE, GDS and Rosenbaum vision test. There were two subjects that were excluded from study participation because of self-reported macular degeneration and they were provided with the appropriate referral list. All remaining participants successfully passed the vision screen. There were no exclusions for MMSE or GDS scores. The mean score of the participants on the MMSE was 27.4 (SD=1.72) with scores ranging from 24 to 30. Scores on the MMSE were analyzed as a continuous variable. MMSE scores were significantly correlated with the working memory composite ($r = .53$, $p<.01$), health literacy($r = .38$, $p<.01$) and recall($r = .54$, $p<.01$). The mean score on the GDS-SF was 0.98 (SD =1.27) with a range of 0-4.

**Working Memory Measures**

The mean score on Mental Arithmetic was 10.71 (SD = 3.70) with a range of 6 to 21. The sub-test Digit Span Forward and Digit Span Backward were combined to create the Digit Span raw scores (Kaufman & Lichtenberger, 1999). The mean raw score was 15.0 (SD = 4.10) with a range of 9 to 26. The Letter-Number Sequencing test mean score was 5.5 (SD=2.86) with a range of 0-16. Since the three working memory scales were measured on different metrics, a composite
working memory score was created by first transforming each of the scales using a Z-score equation and then averaging the scores together. This process allows for the comparison of scores obtained from different measures (Howell, 2008). The composite working memory score range was -1.21 to 2.88 (SD = 0.88) and had a good reliability (α = .86). The reliability of the composite working memory score was calculated by using the 3 Z-scored working memory scales and entering them into the reliability function in the SPSS statistical program.

Health Literacy Measure

The S-TOFHLA was used to assess health literacy among study participants. The mean health literacy score was 25.4 (SD = 11.08) and ranged from 5 to 36 with a median score of 33.

Recall

At the conclusion of the study participants were asked to recall as many of the warning signs of stroke that they could remember. The time between reading the list and later recall varied between 60 and 90 minutes. The mean number of the five warning signs remembered was 2.9 (SD=1.33) with a range of 0 to 5 (Table3). Recall was normally distributed in this sample (Figure 3).
Figure 3

Working Memory Histogram

Table 3

Variables of Interest (N=56)

<table>
<thead>
<tr>
<th>Working Memory Measures</th>
<th>Mean (SD)</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mental Arithmetic</td>
<td>10.71 (3.70)</td>
<td>6 - 21</td>
</tr>
<tr>
<td>Digits Forward</td>
<td>9.19 (2.48)</td>
<td>5 - 16</td>
</tr>
<tr>
<td>Digits Backward</td>
<td>5.78 (2.15)</td>
<td>2 - 11</td>
</tr>
<tr>
<td>Composite (Digits F/B)</td>
<td>15.05 (4.10)</td>
<td>9 - 26</td>
</tr>
<tr>
<td>Letter-Number Sequence</td>
<td>5.50 (2.86)</td>
<td>0 - 16</td>
</tr>
<tr>
<td>Working Memory Composite</td>
<td>.00 (0.88)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Health Literacy</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>STOFHLA</td>
<td>25.48 (11.08)</td>
<td>5 – 36</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Warning Signs of Stroke</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Recall</td>
<td>2.96 (1.33)</td>
<td>0 - 5</td>
</tr>
</tbody>
</table>

Note: SD – standard deviation
Correlational Analysis

A correlation matrix of all continuous variables and recall was constructed to examine the covariance between variables. The analysis was reviewed for expected and unexpected outcomes. Zero-order correlations of the key variables of interest are displayed in Table 4.

Table 4

Zero Order Correlations Working Memory, Health Literacy and Recall

<table>
<thead>
<tr>
<th>Variables</th>
<th>Arithm</th>
<th>Digitsfb</th>
<th>L-N</th>
<th>STOFHLA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Digitsfb</td>
<td></td>
<td>.65**</td>
<td></td>
<td></td>
</tr>
<tr>
<td>L-N</td>
<td>.67**</td>
<td>.73**</td>
<td></td>
<td></td>
</tr>
<tr>
<td>STOFHLA</td>
<td>.55**</td>
<td>.57*</td>
<td>.41**</td>
<td></td>
</tr>
<tr>
<td>Recall</td>
<td>.37*</td>
<td>.30*</td>
<td>.35**</td>
<td>.44**</td>
</tr>
</tbody>
</table>

Research Question One

“What are the relationships among the three key variables of working memory capacity, health literacy and information recall of the five warning signs of stroke among community dwelling older adults?” A correlation table of the 3 primary variables of interest was constructed. Results indicate that both working memory as measured by the WMI subtest and health literacy are significantly correlated with recall (Table 5).

The composite working memory score (Arithmetic, Digits Forward/Backward and Letter-number Sequencing) was significantly correlated with recall ($r = .38$, $p < .01$). Additionally, the two independent variables, working memory and health literacy are also quite highly correlated with one another. Given the higher correlation between the two independent variables
themselves compared to either of the independent variables with the outcome variable of recall, there may be relatively little unique variability in either of them that may predict recall. However, the health literacy variable has a slightly higher correlation with recall and in later regression analysis, was more predictive of recall than working memory in this sample. Health literacy was strongly correlated, \( r = .44, p< .01 \) with the recall of the five warning signs of stroke.

Table 5

<table>
<thead>
<tr>
<th></th>
<th>STOFHLA</th>
<th>Recall</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recall</td>
<td>.44**</td>
<td></td>
</tr>
<tr>
<td>WorkMem</td>
<td>.57**</td>
<td>.38*</td>
</tr>
</tbody>
</table>

Note. WorkMem = Working Memory Composite (Arithmetic, Digits Forward/Backward, Letter-Number Sequencing); STOFHLA= Short Test of Functional Health Literacy Adults; Recall = Warning Signs of Stroke.

*\( p< .05 \), **\( p< .01 \)

Research Question Two

“Is there an interaction between working memory capacity and health literacy in predicting the information recall of the five warning signs of stroke among community dwelling older adults?” was examined by first including only the 2 predictors (working memory and health literacy) into the regression model. To test whether the interaction between these two variables predicted additional variance in recall scores, a second model included the interaction term as well as the main effects of working memory and health literacy. The main effects only model indicates that health literacy positively predicts recall \( \beta = .33 \) and is significant at the \( p < .05 \) level. Working memory, however, does not significantly predict recall.
(β = .19, p = .20) when health literacy is entered simultaneously and no interaction effect was found. The standardized coefficient (Beta) for health literacy is larger than that for working memory. The regression analysis results indicate that multicollinearity exists between the predictors working memory and health literacy.

The second model included the interaction between health literacy and working memory in addition to the main effects. Health literacy is positively and significantly predictive of recall and is actually larger taking into account the interaction (β = .56, p < .01). The interaction is not significant by conventional standards, however it may be considered a positive trend (β = .28, p = .12) (Table 6). A plot of the interaction is shown in Figure 4. The figure shows that for individuals with above average health literacy scores, and individuals who also have above average working memory scores tend to recall more warning signs of stroke. In this sample, there were no individuals who had above average working memory and below average health literacy, so the plot is truncated in order to prevent inappropriate extrapolation of the results.

Table 6

Summary of Regression Analysis for Working Memory and Health Literacy on Recall

<table>
<thead>
<tr>
<th>Variables</th>
<th>b</th>
<th>SE</th>
<th>Beta (β)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>MODEL 1</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>STOFHLA</td>
<td>.04</td>
<td>.01</td>
<td>.33</td>
<td>.03</td>
</tr>
<tr>
<td>WorkMem</td>
<td>.29</td>
<td>.22</td>
<td>.19</td>
<td>.20</td>
</tr>
<tr>
<td><strong>MODEL 2</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>STOFHLA</td>
<td>.07</td>
<td>.03</td>
<td>.56</td>
<td>&lt; .01</td>
</tr>
<tr>
<td>WorkMem</td>
<td>-.03</td>
<td>.30</td>
<td>-.02</td>
<td>.92</td>
</tr>
<tr>
<td>STOFHLA*WorkMem</td>
<td>.04</td>
<td>.03</td>
<td>.28</td>
<td>.12</td>
</tr>
</tbody>
</table>

Model 1: $R^2=.22$
Model 2: $R^2=.26$
Figure 4

*Working Memory and Health Literacy Interaction*

*Figure showing the interaction between working memory and health literacy.*

- **Working Memory**: The x-axis represents literacy score, with values ranging from 0 to 5.
- **Warning Signs Recalled**: The y-axis represents the number of warning signs recalled, ranging from 0 to 5.
- The graph shows a trend line for both -1SD on working memory and +1SD on working memory, indicating how the number of warning signs recalled changes with literacy score.
Research Question Three

What are the relationships between the personal factors (age, gender, marital status, living arrangement, educational attainment, socioeconomic status and type and number of chronic illness, number of prescriptions) and the key variables (working memory capacity, health literacy and information recall of the five warning signs of stroke) among community dwelling older adults?

A correlation matrix of the key variables (working memory, health literacy, and recall) and personal factors (age, gender, marital status, living arrangement, educational attainment, socioeconomic status and type and number of chronic illness, number of prescriptions) was constructed. Zero-order correlations demonstrated that health literacy was significantly related to educational attainment ($r = .46$). The composite of working memory was negatively correlated with age, gender, and employment status.

Working memory was positively associated with educational attainment, being married or living with someone and having an income that exceeds expenses. Age and educational attainment demonstrated a significant relationship ($r = -.33$, $p < .05$), as did age and working memory measures (Table 7).
Table 7 Zero Order Correlations of Variables of Interest

<table>
<thead>
<tr>
<th>Variables</th>
<th>Age</th>
<th>Gender</th>
<th>EdA</th>
<th>ES</th>
<th>MS</th>
<th>EcoS</th>
<th>Live</th>
<th>CoMor</th>
<th>Meds</th>
<th>MMSE</th>
<th>GDS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td>.07</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
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<tr>
<td>EdA</td>
<td></td>
<td>-.33**</td>
<td></td>
<td>.22</td>
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<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
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<tr>
<td>ES</td>
<td></td>
<td>.55**</td>
<td>.36**</td>
<td>-.25</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>MS</td>
<td></td>
<td>.38**</td>
<td>.22</td>
<td>-.25</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EcoS</td>
<td></td>
<td>.09</td>
<td>.07</td>
<td>-.36**</td>
<td>.07</td>
<td>-.06</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Live</td>
<td></td>
<td>-.20</td>
<td>-.10</td>
<td>.19</td>
<td>-.12</td>
<td>-.49**</td>
<td>.19</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CoMor</td>
<td></td>
<td>.28*</td>
<td>.09</td>
<td>-.01</td>
<td>.23</td>
<td>.01</td>
<td>-.07</td>
<td>.17</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Meds</td>
<td>.10</td>
<td>-.02</td>
<td>-.07</td>
<td>-.07</td>
<td>-.07</td>
<td>.00</td>
<td>.10</td>
<td>.39**</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MMSE</td>
<td>-.21</td>
<td>-.23</td>
<td>.50**</td>
<td>-.33*</td>
<td>-.15</td>
<td>-.24</td>
<td>-.04</td>
<td>.06</td>
<td>.19</td>
<td></td>
<td></td>
</tr>
<tr>
<td>GDS</td>
<td>.15</td>
<td>-.04</td>
<td>.10</td>
<td>-.01</td>
<td>.08</td>
<td>-.14</td>
<td>-.02</td>
<td>.21</td>
<td>.05</td>
<td>-.02</td>
<td></td>
</tr>
<tr>
<td>WorkMem</td>
<td>-.33*</td>
<td>-.39**</td>
<td>.57**</td>
<td>-.38**</td>
<td>.33*</td>
<td>.42**</td>
<td>.28*</td>
<td>.07</td>
<td>.03</td>
<td>.53**</td>
<td>.01</td>
</tr>
<tr>
<td>STOFHLA</td>
<td>-.16</td>
<td>-.10</td>
<td>.46**</td>
<td>-.11</td>
<td>.20</td>
<td>.11</td>
<td>.08</td>
<td>.11</td>
<td>-.11</td>
<td>.38**</td>
<td>.14</td>
</tr>
<tr>
<td>Recall</td>
<td>-.05</td>
<td>-.02</td>
<td>.36**</td>
<td>-.11</td>
<td>.15</td>
<td>.11</td>
<td>.07</td>
<td>.18</td>
<td>.05</td>
<td>.54**</td>
<td>-.07</td>
</tr>
</tbody>
</table>

Note. EdA = Educational Attainment; ES = Employment Status; MS = Marital Status; EcoS = Economic Status; Live = Living Arrangement; CoMor = CoMorbid Conditions; Meds = Medications; MMSE = Mini Mental State Examination; GDS = Geriatric Depression Scale Short Form; WorkMem = Working Memory Composite; STOFHLA= Short Test of Functional Health Literacy Adults; Recall = Warning Signs of Stroke.
*p<.05, **p<.01

Research Question Four

Which of the personal factors (age, gender, marital status, living arrangement, educational attainment, socioeconomic status and type and number of chronic illness, number of
prescriptions) taken together best explain the variance in recall of the five warning signs of stroke among community dwelling older adults? In this study regression analysis was used as the technique for modeling and analyzing several variables, when the focus is on the relationship between a dependent variable (recall) and one or more independent variables (working memory and health literacy). Regression analysis was used to predict which of the personal factors (age, gender, marital status, living arrangement, educational attainment, socioeconomic status and type and number of chronic illness, number of prescription) best predicted recall of the five warning signs of stroke. Overall, the regression model did not demonstrate an increase in the recall of the five warning signs of stroke. However, educational attainment was determined to be a significant predictor of recall in this sample.

Table 8

Summary of Regression Analysis for Personal Factors (Education)

<table>
<thead>
<tr>
<th>Variables</th>
<th>b</th>
<th>SE</th>
<th>Beta (β)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Education</td>
<td>.12</td>
<td>.05</td>
<td>.33</td>
<td>.02</td>
</tr>
</tbody>
</table>

Model 1: $R^2 = .25$

Research Question Five

What key variables and personal factors together best predict information recall of the five warning signs of stroke among community dwelling older adults? The key variable, health literacy was the only factor that was predictive of the recall of the five warning signs of stroke.
Table 9

Summary of Regression Analysis for Key Variables and Personal Factors

<table>
<thead>
<tr>
<th>Variables</th>
<th>b</th>
<th>SE</th>
<th>Beta (β)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>STOFHLA_c</td>
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<td>.25</td>
<td>.52</td>
<td>.01</td>
</tr>
<tr>
<td>WorkMem</td>
<td>-.11</td>
<td>.31</td>
<td>-.07</td>
<td>-.35</td>
</tr>
<tr>
<td>Lit_Mem</td>
<td>.03</td>
<td>.02</td>
<td>.26</td>
<td>.13</td>
</tr>
<tr>
<td>Education</td>
<td>.05</td>
<td>.05</td>
<td>.13</td>
<td>.38</td>
</tr>
</tbody>
</table>

Predictors: (Constant), STOFHLA= health literacy measure, WorkMem= working memory composite, Lit_Mem = interaction health literacy and working memory

Summary of Chapter IV

The results from the analysis of the data collected in a sample of community dwelling older adults were presented in this chapter. Descriptive statistics were used to summarize the data and describe the sample. A correlation matrix was created to explore the strength and direction of a linear relationship between the variables. In conclusion, regression analysis was used to explore select research questions. Findings demonstrate that there was a positive association between the key variable health literacy and recall of the five warning signs of stroke. However, the interaction between the two independent variables, working memory and health literacy did not support that a significant relationship existed. The personal factor, educational attainment (years of schooling) was positively associated with the key variables health literacy, working memory and recall of the five warning signs of stroke in this sample.
CHAPTER V: DISCUSSION

Introduction

In this chapter, each of the proposed research questions will be addressed and the findings discussed. The implications of the study findings for the associations between the key variables, working memory and health literacy, personal factors, and the recall of the five warning signs of stroke are presented. The chapter concludes with a discussion of study limitations and future research.

This study was the first to explore the associations between working memory, health literacy and the recall of the five warning signs of stroke among community dwelling older adults. The results of this study demonstrate that each of the key variables was independently and significantly associated the recall of the warning signs of stroke. However, in regression analysis, the only significant predictor of recall was health literacy.

In a second phase of the analysis the personal factor, educational attainment (years of schooling) was determined to be positively correlated with recall. Additionally, working memory and health literacy were each independently and significantly related to education attainment in this sample. The results provide support that working memory, health literacy and educational attainment are important factors to consider when delivering health information to older adults.

Characteristics of Study Participants

Demographics

Older adults age 65 and older were recruited to participate in this study. The mean age of the sample was 80 years, and participants ranged in age from 68 to 99. Forty percent of the sample was women with the remainder being male. These findings are consistent with the 2001
US census report that found women age 65 and older account for 58.8 percent of the population. Additionally, prior research investigating working memory capacity among older adults has utilized the 65 years and older age range to assess working memory performance (Craik & Salthouse, 2007). Similar age ranges have been used in research examining health literacy among older adults (Baker, Gazmararian, Sudano, & Patterson, 2000b). The overall mean age of this sample was somewhat older than previous investigations and this is attributed to the Senior Center and Retirement Residence recruitment sites. Seventy percent of the study sample was female, and all participants were Caucasian. A large percentage of the group was widowed (70%), not working (80%) and living alone (66%). These findings are consistent with research investigating older adults. The mean educational level was 14.3 years of schooling with a range of 8 to 22 years of education. Fifty-seven percent reported that their income met their expenses and 20% indicated that their expenses exceeded their income. Previous research has shown that adults age 65 and older on average experience lower educational attainment and prose literacy and were from lower socioeconomic groups (Cutilli & Bennett, 2009). The results of the sample characteristics can be partially attributed to the demographic area where participants were recruited and are generalizable to similar populations.

Medical Variables

Sixty-four percent of study participants experienced cardiovascular disease with fourteen percent reporting diabetes. The remaining participants reported experiencing multiple co-morbidities (rheumatoid arthritis, gastrointestinal disease, thyroid disease and cancer) which is a common finding among older community dwelling individuals (Wolff, Boul, Boyd, & Anderson, 2005). Ninety-three percent of participants took prescription medications on a regular
basis with an average of 5.7 medications taken daily. Increasing age is associated with an increase in co-morbid health conditions and the use of prescription drugs. These findings are consistent with several research studies investigating co-morbid health conditions and medication use among older adults (Hajjar, Cafiero, & Hanlon, 2007; Norris, et al., 2008; Ostwald, Wasserman, & Davis, 2006).

Screening Measures

The zero-order correlations reveal that MMSE score and achieved educational level in years, composite working memory score and health literacy were significantly related to recall. The MMSE is commonly used to screen for cognitive impairment and research investigating MMSE and health literacy found that MMSE scores were positively associated with reading comprehension tests like the STOFHLA (Baker, et al., 2002). No significant correlations were found in examining GDS scores, key variables and personal factors.

Research Questions

Research Question One

What are the relationships among the three key variables, working memory capacity, health literacy and information recall of the five warning signs of stroke among community dwelling older adults? This question was answered by examining the correlational relationships between the selected predictor variables (working memory and health literacy) and the criterion recall. In the initial analysis, a correlational matrix was computed on all variables to determine the existence of significance. The results of this analysis show that specifically in this sample participants who had higher working memory capacity scores demonstrated better recall. Research investigating working memory has examined age-related cognitive changes that could
affect older adults’ processing of health information. For example, Park et al. (2002) examined
cognitive functioning of a sample of 345 adults and found that there were linear age declines
from ages 20 to 90 on several effortful cognitive tasks, including working memory. Age-related
cognitive declines may cause older adults to experience difficulty in recalling important health
messages. Studies investigating working memory capacity support that age-related cognitive
changes may play a part in how people learn new health information (Park & Liu, 2007).

In examining the correlational relationship between the second predictor, an increased
degree of health literacy was associated with a positive recall of the warning signs of stroke.
Previous research investigating the role of health literacy among older adults has shown that
having higher health literacy is beneficial to supporting positive health outcomes. In a study
investigating functional health status among older adults, researchers found that individuals with
inadequate health literacy were more likely to report difficulties with instrumental activities of
daily living and had poorer physical and mental health (Wolf, et al., 2005). Additionally
research investigating poor health literacy and declines in cognition independently predict
mortality among older adults (Baker, et al., 2007). Inadequate health literacy has been linked to
less knowledge of proper health behaviors and decreased use of preventive health services
(Gazmararian, et al., 2003; Wolf, et al., 2007).

Research Question Two

Is there an influence of an interaction between working memory capacity and health
literacy in predicting the information recall of the five warning signs of stroke among community
dwelling older adults? To examine the interaction of the predictor variables, working memory
capacity and health literacy a regression analysis was performed. Multiple regression statistics
allows for the prediction of one variable on the basis of several variables (Howell, 2008). The relative contribution of each of the predictor variables was assessed using a Stepwise method where each of the predictor variables was entered in sequence into the linear regression model. The results of this analysis of the two predictors in the model output show that health literacy positively predicts recall and it is significant (p<.05). Working memory capacity, however, does not significantly predict recall (p = .198). The standardized regression coefficient (β) was computed and was consistent with a medium effect size. However, in examining the interaction effect between working memory capacity and health literacy we found no significant relationship. In examining the relationship of interaction between the key predictor variables there was some evidence of an interaction however, findings pointed to a compound effect of working memory capacity and health literacy. The results support that there is a benefit of having higher scores on one measure (working memory) or the other (health literacy) was increased if scores on the other measure were also high (diagram 2). These findings also support that this trend would demonstrate a significant effect with the collection of additional data.

In general, interaction effects are thought of as inherently underpowered (Bowling & Ebrahim, 2005). The result of the large correlation or multicollinearity between working memory capacity and health literacy reduces the power of their interaction effect. The high correlation between the two explanatory variables presents two problems in the case of multivariate data analysis. The first issue is that it reduces the variance explained by the criterion in relation to what would be the case if the predictor variables have the same simple relationships with the dependent variable, but less multicollinearity. The second issue is that multicollinearity results in sample statistics that are a less stable estimate of population parameters. There are different
approaches that can address the issue of multicollinearity between model variables. Initially data should be checked for the improper computing or coding of dummy variables that can produce errors. Another method that can be used to correct multicollinearity is to remove one of the variables from the model to determine if there is a reduction or elimination of this relationship between the variables. In this study, however, removing either of the predictor variables would not allow for testing the null model. Additionally, increasing the sample size is another method that can be employed to reduce or eliminate multicollinearity within the model. Increasing the sample size will narrow the confidence interval and decrease the standard deviation of the parameter estimates and decrease variability. Thus, increasing the sample size may address the conceptual overlap between the two variables by producing more precise parameter estimates with lower standard errors that are better able to isolate their unique effects. Your approach to addressing multicollinearity should be guided by the conceptual model explaining relationships among the variables.

**Research Question Three**

What are the relationships between the personal factors (age, gender, marital status, living arrangement, educational attainment, socioeconomic status and type and number of chronic illness, number of prescriptions) and the key variables (working memory capacity, health literacy and information recall of the five warning signs of stroke) among community dwelling older adults? A correlational analysis was performed to determine the relationships between the personal factors and the key variables investigated in this study. The results of the correlation matrix showed that there was a significant relationship (p<.01) between the personal factor of
education and health literacy in this sample. There was a positive relationship between education and the composite measure of working memory. Education was also positively associated with the number of warning signs of stroke that the older adults participating in this study recalled. The role of education in determining health literacy is established in the research literature (Martin, et al., 2009). Previous research investigating the relationship between health literacy and education supports that there is a positive relationship between education and health literacy (Baker, et al., 2000b; Cutilli & Bennett, 2009; Gazmararian, et al., 1999).

Research investigating age-related changes in cognition has established associations with lower educational attainment (Ardila, Ostrosky-Solis, Rosselli, & Gomez, 2000). Older adults with limited literacy skills have been found to experience more pronounced declines in cognitive functioning. Manly et al. (2003) found that having higher literacy skills among older adults was protective against memory decline among non-demented adults. Age was negatively associated with the working memory composite. As age increased, working memory capacity decreased. This finding is consistent with previous research investigating the relationship between age and working memory capacity (Craik, 1994; Craik & Bialystok, 2006; Reuter-Lorenz & Lustig, 2005).

*Research Question Four*

Which of the personal factors (age, gender, marital status, living arrangement, educational attainment, socioeconomic status and type and number of chronic illness, number of prescriptions) taken together best explain the variance in information recall of the five warning signs of stroke among community dwelling older adults? To answer this question a regression analysis of all of the personal factors was computed and the significance criterion was set at
p<.05. Model analysis revealed that educational attainment was the only personal factor that significantly predicted recall of the warning signs of stroke in this study.

**Research Question Five**

What *key* variables and *personal* factors together best predict information recall of the five warning signs of stroke among community dwelling older adults? The final research question was analyzed using multiple regression statistics. Results of the analysis show that health literacy was the only factor predictive of the recall of the five warning signs of stroke. These findings are supported in previous research that investigated the relationships between health literacy among older adults.

**Model Summary**

This study was based on the proposed theoretical model that the interaction between working memory capacity and health literacy would predict recall of the warming signs of stroke among a sample of community dwelling older adults. The model also posits that the key variables together with the examined personal factors contribute to the outcome of recall. The results of this study support that there were significant, albeit independent associations between recall and the key predictor variables. The personal factor of education was determined to be positively associated with working memory, health literacy and recall. The proposed model does not fully take into account the internal and external factors that may influence an individual’s ability to remember as well as to obtain, process and understand health information at the time that it is needed. Internal or psychological factors that warrant further exploration are individual perceptions and beliefs regarding the importance of health information and understanding the significance of adhering to health recommendations. Research investigating gender differences
have demonstrated that women show more interest in discussing health related information and engage in more social activities such as structured exercise programs (Logsdon, Hochhalter, & Sharkey, 2009). These types of behaviors should be considered in the development of a model exploring the personal factors that may influence both working memory and health literacy research. Factors such as the amount and type of information and the complexity of the content that is being delivered are important considerations when presenting information to older adults. Cognitive overload theory proposes that when presented material is difficult to understand as is in the case when many elements must be held together in working memory then some information is lost (Park, et al., 1999). Examining the factors that may influence recall may be critical to understanding why there is a delay in seeking treatment or why treatment is not sought out at all. Future research will consider these factors and incorporate them into the development of an expanded model.

Study Limitations

The preliminary findings of this descriptive study are important, however, the research has several limitations. A challenge in this study was recruitment. Initially recruitment of study participants began in March 2009 at the approved recruitment site. Participants were actively recruited at the first site for three months. Initially participants were recruited with ease however after a three month period it became apparent to the investigator that the pool of available participants at the Senior Center was exhausted. The researcher found that it would be necessary to add an additional site to increase enrollment in the study in order to achieve the targeted number of 59 study subjects. An amendment was submitted to the IRB for approval prior to expanding recruitment. The second site was a Retirement Residence and participation in the
study was enthusiastic among the older adults at this site. An additional limitation of the study was the convenience sampling method used, which could lead to recruitment bias and that participants in this study population were homogenous. Future research should take this into consideration.

The model presented in this study is does not take into account the complexities of the working memory construct. Working memory is multifaceted and there continues to be debate among researchers as to the components of this construct (Baddeley, 2000; Buchsbaum & D'Esposito, 2008; Engle, Tuholski, Laughlin, & Conway, 1999). Additionally, there are multiple factors have been identified in the literature that influence performance of an individuals working memory. Researchers investigating this construct support that working memory is capacity limited and that the amount of information that can theoretically be held on-line in mind at any one time declines linearly with age (Craik, 1994). Recent research investigating the capacity limited model suggests that working memory can be improved upon despite advancing age and that it is not as fixed as once thought but rather varies from individual to individual (Jonides, et al., 2008). This should be addressed in future research.

Future Research

This study set out to descriptively explore the relationships between working memory capacity, health literacy and the recall of the five warning signs of stroke in a sample of community dwelling older adults. Findings from this dissertation research support that working memory capacity and health literacy are independently associated with the recall of the warning signs of stroke. Research investigating working memory has shown that varying degrees of task difficulty or the amount of cognitive load that an individual experiences may influence the
amount of information that can be held in mind at any one time (Smiler, Gagne, & Stine-Morrow, 2003). Learning new health information can be considered an effortful task that may require older adults to utilize more cognitive resources. Future research investigating the relationship between working memory, health literacy and the recall of health information should consider the amount and type of information that is being presented. Additionally future research should more fully explore the relationships of personal characteristics such as education and recall.

Education is an important factor to consider when presenting written health information to older adults and may influence recall of information. Previous research studies have used education as the primary marker for literacy skills (Davis, et al., 2006a; Williams, Davis, Parker, & Weiss, 2002; Wolf, et al., 2004). Education, although highly correlated with an individual’s functional ability and reading level, cannot accurately predict their ability to interpret information (Schwartzberg, et al., 2005). Future research investigating health literacy should consider the amount and type of information that is presented to older adults.

Summary: Chapter V

This study provides evidence for the critical role of working memory and health literacy in the recall of the five warning signs of stroke in a sample of community dwelling older adults. Research investigating working memory supports that as we age the ability to successfully hold and manipulate information in mind decreases (Salthouse, 1994). Older adults that experience declines in working memory may be at greater risk for not recalling important health messages such as the warning signs of stroke. The older adults’ ability to remember important information related to signs of an impending stroke is critical to the outcome of this medical emergency. The
understanding of how working memory is associated with recall can provide information on how to make health messages more accessible in real-life situations.

 Associations between health literacy and recall were established in this study. The older adults’ degree of health literacy is an important factor that should be considered when delivering health information. Further investigation is needed to better understand the role of working memory and its relationship to recall of health messages in this population.
APPENDIX A. DATA COLLECTION FORMS

A1. PATIENT DEMOGRAPHIC QUESTIONNAIRE
A2. MINI-MENTAL STATE EXAMINATION
A3. GERIATRIC DEPRESSION SCALE SHORT FORM
A4. MENTAL ARITHMETIC
A5. DIGITS FORWARD AND DIGITS BACKWARD
A6. LETTER-NUMBER SEQUENCING
A1. PATIENT DEMOGRAPHIC QUESTIONNAIRE
A1. PATIENT DEMOGRAPHIC QUESTIONNAIRE

Demographic Questionnaire

ID: __________________________ Date:_________________________

We would like to collect information about you. We will be asking you a few questions please answer to the best of your ability.

Thank You.

<table>
<thead>
<tr>
<th></th>
<th>Question</th>
<th>Options</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>What is your gender?</td>
<td>M            F</td>
</tr>
<tr>
<td>2</td>
<td>What is your Birthday?</td>
<td>My Birthday is:</td>
</tr>
<tr>
<td>3</td>
<td>What is your marital status?</td>
<td>Single         Married    Divorced Widowed</td>
</tr>
<tr>
<td>4</td>
<td>How many years of education do you have?</td>
<td>I completed grade:</td>
</tr>
<tr>
<td>5</td>
<td>What is your employment status?</td>
<td>Working         Not Working</td>
</tr>
<tr>
<td>6</td>
<td>How many people, including yourself, are there in your household?</td>
<td># of people I live with:</td>
</tr>
<tr>
<td>7</td>
<td>Income: Check the statement that best describes your financial situation</td>
<td>My income exceeds my expenses; I have no trouble paying my bills____ My income meets my expenses, I pay my bills____ My income barely meets my expenses; I have little money left over after paying my bills____ My income does not meet my expenses; I usually cannot pay my bills on time____ Refused to answer</td>
</tr>
<tr>
<td>8</td>
<td>Do you have any chronic illnesses?</td>
<td>Yes          No</td>
</tr>
<tr>
<td>9</td>
<td>Please list the chronic conditions that you have:</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Do you take any prescription medications regularly?</td>
<td>Yes          No</td>
</tr>
<tr>
<td></td>
<td>If yes, please indicate how many_______________________________________</td>
<td></td>
</tr>
</tbody>
</table>
A2. MINI-MENTAL STATE EXAMINATION
### A2. MINI-MENTAL STATE EXAMINATION

#### The Mini-Mental State Exam

<table>
<thead>
<tr>
<th>Maximum</th>
<th>Score</th>
<th>Orientation</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td></td>
<td>What is the year (season) (date if April) (month)?</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Where are we (state country town hospital) (shore)?</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Registration</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
</tr>
</tbody>
</table>

Name 3 objects 1 second to say each. Then ask the patient if all 3 after you have said them. Give 1 point for each correct answer. Then repeat them until he/she learns all 3. Count trials and record.

<table>
<thead>
<tr>
<th>Attention and Calculation</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
</tr>
</tbody>
</table>

Serial 7s, 1 point for each correct answer. Stop after 5 answers. Alternately spell "world" backward.

<table>
<thead>
<tr>
<th>Recall</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
</tr>
</tbody>
</table>

Ask for the 3 objects repeated above. Give 1 point for each correct answer.

<table>
<thead>
<tr>
<th>Language</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
</tr>
</tbody>
</table>

Name a pencil and match. Repeat the following: "Mr. John, open, or hold."

<table>
<thead>
<tr>
<th>Total Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
</tr>
</tbody>
</table>

Copy the design shown.

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**MINI-MENTAL STATE: A PRACTICAL METHOD FOR GRADING THE COGNITIVE STATE OF PATIENTS WITH CLINICAL ALZHEIMER'S DISEASE**


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![Image of a design to be copied](https://www.betterhelp.org)
A3. GERIATRIC DEPRESSION SCALE SHORT FORM
A3. GERIATRIC DEPRESSION SCALE SHORT FORM

Geriatric Depression Scale -SF (short form)

Choose the best answer for how you have felt over the past week:

1. Are you basically satisfied with your life? YES / NO
2. Have you dropped many of your activities and interests? YES / NO
3. Do you feel that your life is empty? YES / NO
4. Do you often get bored? YES / NO
5. Are you in good spirits most of the time? YES / NO
6. Are you afraid that something bad is going to happen to you? YES / NO
7. Do you feel happy most of the time? YES / NO
8. Do you often feel helpless? YES / NO
9. Do you prefer to stay at home, rather than going out and doing new things? YES / NO
10. Do you feel you have more problems with memory than most? YES / NO
11. Do you think it is wonderful to be alive now? YES / NO
12. Do you feel pretty worthless the way you are now? YES / NO
13. Do you feel full of energy? YES / NO
14. Do you feel that your situation is hopeless? YES / NO
15. Do you think that most people are better off than you are? YES / NO

Answers in bold indicate depression. Although differing sensitivities and specificities have been obtained across studies, for clinical purposes a score > 5 points is suggestive of depression and should warrant a follow-up interview. Scores > 10 are almost always depression.
A4. MENTAL ARITHMETIC
Arithmetic

Materials
Arithmetic Problems (20) in Manual
Block Design Blocks (9)
Stopwatch

Description
For this subtest, the examinee is presented with a series of arithmetic word problems to be solved mentally, without the use of pencil or paper, and responds orally with a time limit.

Start

Item 5
If the examinee obtains perfect score (1 point) on both Items 5 and 6, give full credit for Items 1-4.

Reverse
If the examinee scores 0 on either Item 5 or Item 6, administer Items 1-4 in reverse sequence until the examinee obtains perfect score on two consecutive items. If the examinee obtained a perfect score on Item 5, count it in the reverse sequence. When this criterion is met, give full credit for any preceding items that were not administered. Then proceed with the subtest until the discontinue criterion are met.

Discontinue
Discontinue after four consecutive scores of 0.

General Directions
• Begin timing each item immediately after you read the problem to the examinee. A problem may be repeated once if the examinee requests, or it is apparent the examinee failed to understand the task. However, timing always begins at the end of the first reading of the problem.
• The examinee may not use pencil or paper for any problem. However, do not discourage the examinee from using a finger to “write” on the table.
• In the Completion Time column on the Record Form, record the exact amount of time the examinee takes to solve each problem, if it is within the time limit. The time limit for each item is provided in the Item Instructions on the Record Form. Timing begins immediately after the problem has been read. Accurate recording of
completion times is essential because the examinee may receive bonus points on Items 19 and 20.

- To introduce the subtest, say: Now we are going to switch tasks again. In this next section, I will ask you to solve some arithmetic problems.

**Item Instructions**

**Scoring**
For each item record the response verbatim and the time the examinee takes to respond. Consider a response correct if the numerical quantity is correct, regardless of whether appropriate units (e.g. dollars and cents) are included in the response. In addition, give credit if the examinee spontaneously corrects a wrong response within the time limit.

If the examinee obtained perfect scores on items 5 and 6, give 1-point credit for each of the Items 1-4. If some but not all reversal items were administered because the examinee responded correctly to two consecutive items, give 1-point credit for each of the unadministered reversal items.

If the examinee responds correctly after the time limit, record 0 points for the response.

For items 1-18, record 1 point for each correct response provided within the time limit. For items 19 and 20, record 2 points for each correct response provided in 1-10 seconds or 1 point for a correct response provided within the time limit but not in 10 seconds or less. Maximum Score 22 points.
A5. DIGITS FORWARD AND DIGITS BACKWARD
A5. DIGITS FORWARD AND DIGITS BACKWARD

Digit Span

Materials
Digits Forward and Digits Backward Items
In Manual and on Record Form

Description
Digit Span is composed of two tasks administered independently of each other: Digits Forward and Digits Backward. On both tasks, the examiner reads a series of number sequences to the examinee. For each Digits Forward Item, the examinee is required to repeat the number sequence in the same order as presented. For Digits Backward, the examinee is required to repeat the number sequence in the reverse order.

General Directions:
The two parts of Digit Span-Digits Forward and Digits Backward- are administered separately.

Administer Digits Backward even if the examinee obtains a score of 0 on Digits Forward.

Administer both trials of each item even if the examinee passes Trial 1.

Read the digits at the rate of one per second, dropping your voice inflection slightly on the last digit in the sequence. Pause to allow the examinee to respond.

Digits Forward

Start
Trial 1 of Item 1

Discontinue
Discontinue after a score of 0 on both trials of any one item.

Item Instructions
Before administering Trial 1 of Item 1, say:

I am going to say some numbers. Listen carefully; when I am through, I want you to say them right after me. Just say what I say.
Digits Backward

Start

Trial 1 of Item 1

Discontinue

Discontinue after a score of 0 on both trials of any one item

Item Instructions

Say:

Now I am going to say some more numbers. But this time when I stop, I want you to say them backward. For example, if I say 7-1-9, what would you say?

If the examinee responds correctly (9-1-7), say

That’s right.

Proceed to Trial 1 of Item 1. However, if the examinee responds incorrectly, provide the correct response and say:

No, you would say 9-1-7. I said 7-1-9, so to say it backward, you would say 9-1-7. Now try these numbers. Remember, you are to say them backward: 3-4-8.

Do not provide any assistance on this example or any of the items. Whether or not the examinee responds correctly (i.e. 8-4-3), proceed to Trial 1 of item 1.

Scoring

Each item is scored 0, 1, or 2 points as follows”

- 2 points if the examinee passes both trials
- 1 point if the examinee passes only one trial
- 0 points if the examinee fails both trials

Maximum Score on Digits Forward: 16 points

Maximum Score on Digits Backward: 14 points

Maximum Score on Digit Span: 30 points
A6. LETTER-NUMBER SEQUENCING
A6. LETTER-NUMBER SEQUENCING

Letter-Number Sequencing

Say I am going to say a group of numbers and letters. After I say them, I want you to tell me the number first, in order, starting with the lowest number. Then tell me the letters in alphabetical order. For example; if I say B-7, your answer should be 7-B. The number goes first, then the letter. If I say 9-C-3, then your answer should be 3-9-C, the numbers in order first, then the letters in alphabetical order. Let’s practice.

Administer all practice trials. Say each combination at a rate of one number or letter per second. Allow the examinee ample time to respond (correct responses are in parentheses).

6-7  (6-F)
G-4 (4-G)
3-W-5 (3-5-W)
T-7-L (7-L-T)
1-J-A (1-A-J)

If the examinee makes an error on any practice trial, correct her or him and repeat the instructions as necessary. Even if the examinee fails all practice trials, continue with the subtest.

Proceed to Item 1. Administer the items from the Record Form. Record the examinee’s responses.
APPENDIX B: RECRUITMENT SCRIPT
Good afternoon, my name is Christine Ganzer and I am a graduate student in the College of Nursing at the University of Arizona. I am looking for a group of individuals age 65 and older to participate in my research study. The purpose of the study is to investigate how our memory and our health literacy, the understanding of written health information influence how we recall basic health information needed to make appropriate health care choice. The study is called “Associations between Working Memory, Health Literacy and Recall of the Warning Signs of Stroke Among Older Adults”. The study will take approximately 1-2 hours of your time to complete. Participation in this study is voluntary and you can stop your participation in this study at any time without penalty. If you choose to be part of the study I will be asking you to read and sign a consent form. Then the study will begin with the completion of two short questionnaires and a vision test that will determine if you can continue with the full study. The questionnaires will be asking you questions about your memory, and your mood. The vision test will determine how well you can see things up close. If you cannot go on with the study we will discuss the reasons and you will be given information about what you can do. Participants that continue with the second part of the study will be asked to read a brochure that discusses important information about stroke. When you are finished you will be given a short memory test and a short test on health literacy. At the end you will be asked a few questions about what you learned during your participation in this study. You should know that you may not receive any personal benefit except perhaps to learn about the warning signs of stroke, but I am hopeful that by conducting this study that I will gain information that will help direct nurses and other members of the health care team, to understand how older adults learn about health care information.

If you have any questions concerning the research study at any time before, during or after the study has ended you may ask either in person or please call me at (914) 960-8270. This will be the end of your participation in this study.
APPENDIX C: CONSENT FORMS
APPENDIX C: CONSENT FORMS

Informed Consent

Project Title: Associations between Working Memory Capacity, Health Literacy and Recall of the Warning Signs of Stroke Among Older Adults

Introduction

You are being invited to take part in a research study. The information in this form is provided to help you decide whether or not to take part. Study personnel will be available to answer your questions and provide additional information. If you decide to take part in the study, you will be asked to sign this consent form. A copy of this form will be given to you.

What is the purpose of this research study?

The purpose of this project is to investigate the association between memory, the understanding of written health information (health literacy), and recall of printed health information concerning the warning signs of stroke in community dwelling older Americans. Because stroke is common in older Americans, recollecting information about the warning signs of stroke may be useful.

Why are you being asked to participate?

You are being invited to participate in this study because you are 1) 65 years of age or older, 2) able to speak, read and write English and 3) have expressed that you are willing to participate in the study.

How many people will be asked to participate in this study?

Approximately 60 persons will be asked to participate in this study.

What will happen during this study?

If you agree to participate in this study you will be invited to the Country House 2000 Baldwin Road, Yorktown Heights, NY 10598. On the day of the study visit you will come to the Country House for your scheduled appointment. You will be asked to have a vision test that will involve reading letters on a card that will be placed 14 inches away from you. If you wear glasses you may leave them on. You will be asked to complete two additional paper and pencil tests. The first questionnaire asks you about your thinking and remembering abilities. Based on these measures you will either be invited to continue your participation in the study or you will not be eligible to participate. If it is determined that you are not...
able to continue with the study you will be given information about why you are unable to continue and you will be given information about community resources that may help you. If you continue with the study you will be asked about your date of birth and the number of years of formal education. You are free to not answer any question and to stop participating at any time without penalty. All questionnaires are coded with a number rather than your name and the forms will be kept confidential by the study Principal Investigator. As a part of this study you will be asked to complete three additional questionnaires that involve questions about memory and health literacy. You will also be asked to read a brochure that is published by the American Stroke Association. At the end of the study you will be asked to answer a few questions about what you learned during your study visit. This will conclude your participation in this study.

**How long will I be in this study?**

About 1 to 2 hours will be needed to complete this study.

**Are there any risks to me?**

Although we have tried to avoid risks, you may feel that some questions we ask you to answer may be upsetting. If this occurs you can stop participating immediately. We can give you information about individuals who may be able to help you with these problems.

**Are there any benefits to me?**

You will not receive any benefit from taking part in this study.

**What are the alternatives for participating in this study?**

The alternative is not to participate in this study.

**Will there be any costs to me?**

Aside from your time (1 to 2 hours), there are no costs for taking part in the study.

**Will I be paid to participate in the study?**

You will not be paid for your participation.

**Will video or audio recordings be made of me during the study?**

No.

**Will the information that is obtained from me be kept confidential?**

Version: 12209
The only person who will know that you participated in this study will be: Christine Ganzer, Principal Investigator.

Your records will be confidential. You will not be identified in any reports or publications resulting from the study. Representatives of regulatory agencies including The University of Arizona Human Subjects Protection Program may access your records.

What if I am harmed by the study procedures?

Side effects or harm are possible in any research program despite the use of high standards of care and could occur through no fault of yours or the investigator involved. Known side effects have been described in this consent form. However, unforeseeable harm also may occur and require care. You do not give up any of your legal rights by signing this form. In the event that you require or are billed for medical care that you feel has been caused by the research, you should contact the principal investigator Christine Ganzer, Ph.D., Candidate at 914-900-8270.

May I change my mind about participating?

Your participation in this study is voluntary. You may decide to not begin or to stop the study at any time. Your refusing to participate will have no effect on you. You can discontinue your participation with no effect on you. If you choose not to participate in this study it will not influence your ability to continue to participate in activities at the Senior Center. Any new information discovered about the research will be provided to you. This information could affect your willingness to continue your participation.

Whom can I contact for additional information?

You can call the Principal Investigator to tell him/her about a concern or complaint about this research study. The Principal Investigator Christine Ganzer, Ph.D., student can be contacted at 914-900-8270. If you have questions, complaints, or concerns about the research and cannot reach the Principal Investigator; or want to talk to someone other than the Investigator, you may call the University of Arizona Human Subjects Protection Program office at (520) 626-6721. If you have questions, complaints, or concerns about the research and cannot reach the Principal Investigator; or want to talk to someone other than the Investigator, you may call the University of Arizona Human Subjects Protection Program office at (520) 626-6721. If you have questions, complaints, or concerns about the research and cannot reach the Principal Investigator; or want to talk to someone other than the Investigator, you may call the University of Arizona Human Subjects Protection Program office at (520) 626-6721.

If you would like to contact the Human Subjects Protection Program via the web (this can be anonymous), please visit http://www.med.arizona.edu/hspp/.

Your Signature

Version: 12209  Page 3 of 4  Participant’s Initials ___
By signing this form, I affirm that I have read the information contained in the form, that the study has been explained to me, that my questions have been answered and that I agree to take part in this study. I do not give up any of my legal rights by signing this form.

Name (Printed)

Participant’s Signature ___________________________ Date signed ___________________________

Statement by person obtaining consent

I certify that I have explained the research study to the person who has agreed to participate, and that he or she has been informed of the purpose, the procedures, the possible risks and potential benefits associated with participation in this study. Any questions raised have been answered to the participant’s satisfaction.

Name of study personnel ___________________________

Study personnel Signature ___________________________ Date signed ___________________________

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Participant’s Initials ______
APPENDIX D: LETTERS OF APPROVAL

APPENDIX D1: IRB LETTER OF APPROVAL

APPENDIX D2: SITE LETTER OF APPROVAL – SENIOR CENTER

APPENDIX D3: SITE LETTER OF APPROVAL – RETIREMENT RESIDENCE
17 March 2009
Christine Ganzer, PhD Student
College of Nursing
P.O. Box 210203

RE: PROJECT NO. 09-0124-02 Associations Between Working Memory Capacity, Health Literacy and Recall of the Warning Signs of Stroke Among Older Adults

Dear Ms. Ganzer:

We received your research proposal as cited above. The procedures to be followed in this study pose no more than minimal risk to participating subjects and have been reviewed by the Institutional Review Board (IRB) through an Expedited Review procedure as cited in the regulations issued by the U.S. Department of Health and Human Services [45 CFR Part 46.110(b)(1)] based on their inclusion under research categories. Although full Committee review is not required, the committee will be informed of the approval of this project. This project is approved with an expiration date of 16 March 2010. Please make copies of the attached IRB stamped consent documents to consent your subjects. The Institutional Review Board (IRB) of the University of Arizona has a current Federal wide Assurance of compliance, FWA00004218, which is on file with the Department of Health and Human Services and covers this activity. Approval is granted with the understanding that no further changes or additions will be made either to the procedures followed or the consent form(s) used (copies of which we have on file) without the knowledge and approval of the Institutional Review Board. Any research related physical or psychological harm to any subject must also be reported to the appropriate committee. Approval is also granted with the condition that all site authorization letters will be submitted to the IRB prior to data collection. A university policy requires that all signed subject consent forms be kept in a permanent file in an area designated for that purpose by the Department Head or comparable authority. This will assure their accessibility in the event that university officials require the information and the principal investigator is unavailable for some reason.

Sincerely yours,

Thomas Park, PhD
Co-Chair, IRB 2
APPENDIX D2: SITE LETTER OF APPROVAL – SENIOR CENTER
APPENDIX D2: SITE LETTER OF APPROVAL – SENIOR CENTER

Port Washington Senior Center
80 Manchaven Blvd
Port Washington, NY 11050

Date: January 6, 2009

Principal Investigator
Christine Anne Ganzer, Ph.D. Candidate
University of Arizona College of Nursing
27 Beacon Hill Rd
Port Washington, NY 11050

Dear Ms. Ganzer,

I have reviewed your request regarding your study and am pleased to support your research project entitled "Associations between Working Memory Capacity, Health Literacy and Recall of the Warning Signs of Stroke Among Older Adults". Your request to use the Port Washington Senior Center as a research or recruitment site is granted. The research will include the recruitment of study participants. This authorization covers the time period of 01/01/2009 to 12/31/2009. We look forward to working with you.

Sincerely,

Dolores Holloway
Director, Port Washington Senior Center
APPENDIX D3: SITE LETTER OF APPROVAL – RETIREMENT RESIDENCE
APPENDIX D3: SITE LETTER OF APPROVAL – RETIREMENT RESIDENCE

Country House  
2000 Baldwin Rd  
Yorktown Heights, NY 10598

Date: July 19, 2009

Principal Investigator  
Christine Anne Ganzer, Ph.D. Candidate  
University of Arizona College of Nursing  
27 Beacon Hill Rd  
Port Washington, NY 10598

Dear Ms. Ganzer,

I have reviewed your request regarding your study and am pleased to support your research project entitled "Associations between Working Memory Capacity, Health Literacy and Recall of the Warning Signs of Stroke Among Older Adults". Your request to use the Country House as a research or recruitment site is granted. The research will include the recruitment of study participants. This authorization covers the time period of 07/01/2009 to 10/31/2009. We look forward to working with you.

Sincerely,

[Signature]

Anita Lary  
Administrator, Country House
REFERENCES


Neuropharmacology.


Weiss, B. D., Francis, L., Senf, J. H., Heist, K., & Hargraves, R. (2006). Literacy Education as Treatment for Depression in Patients with Limited Literacy and Depression: A Randomized Controlled Trial. *Journal of General Internal Medicine, 21*(8), 823-828.


